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A SEWERAGE SYSTEM FOR GUADALAJARA, Mexico, is to be started at once, $100,000 having been appropriated for building some 25 miles of sewers in the western part of the city. The separate system will be used. This is made necessary by the fact that no rain falls during eight months of the year. Pipe being very expensive on account of freight and exchange rates, egg-shaped brick sewers will be built. These will be generally ½ × ¾ meters (19½ × 28¼ ins.), with a very contracted bottom. Flush tanks will be freely used. Mr. C. H. M. Blake will be engineer of the system. Guadalajara now has a death rate of 34 per 1,000.

THE SUPERIOR-DULUTH HARBOR WORK was noted in our issue of March 4, upon data taken from the "Telegram," of Superior, Wis. The statement was then made that clam-shell dredges were to be used and that the contractors had yet to secure the 20 dredges necessary. We are now informed by Major Clinton B. Sears, Corps of Engineers, U. S. A., in charge of the work, that clam-shell dredges will not be used, as they are unfitted for the work, and that the successful bidders already own ten or eleven dredges and have an option on chartering as many more as they want. The full bids for this work were published in our issue of Feb. 25.

THE BRAZOS RIVER HARBOR WORKS and channel improvements have been reported upon by a board of engineers, with a view to their purchase by the government. The improvement of the mouth of this river has been carried on by the Brazos River & Dock Co., with Mr. E. L. Corthell, M. Am. Soc. C. E., as engineer. This company has also secured control of about 26,000 acres of land near the mouth of the river. The result of the jetty work performed has been to increase the depth in the channel from 6 ft., in March, 1889, to 19 ft. in March, 1896. But this depth is still controlled to a considerable extent by the different stages of the river; being deepest after a freshet and shoaling to 14.8 ft. after a period of comparatively low water. Bars in the river above the shore end of the jetties also require dredging. The board of engineers estimate the actual cost of the works, less interest and official salaries, at $1,036,025. They report that so long as this port is in the control of a private company its value to commerce must be small, especially is there is a free port with deeper water 40 miles away, at Galveston. Under these circumstances the Brazos River Company cannot collect channel dues; and without these dues, or some tax on commerce, they cannot afford to maintain the channel. Mr. Corthell reported to the president of the company, in April, 1896, that the jetties were in such condition that a good, navigable channel of 18 ft. can be maintained by expending $50,000 per year for 10 years, and not exceeding $25,000 per year for 5 years thereafter, with only an occasional resort to dredging. Thereafter the annual expense would not be more than $5,000 to $10,000. The board, after giving these estimates and adding that the 26,000 acres lying near the jetties have a single ownership which thus decreases the public interest in the work of improvement, says that until the responsibility for the maintenance of the channel is assumed by the government the confidence necessary to invite capital and inspire enterprise will be impossible. The Brazos Company, to remove objections arising from single ownership, offered the board to dedicate to the public one mile of the river front either all on one side or divided between the two sides, and this the board thinks should be done before the government should assume any responsibility. The board finally says that the maintenance of the harbor is of sufficient public interest to warrant the government in completing the works and maintaining them in the interests of commerce; but it does not think that any payment should be made to the company for so doing. The relief of the company from the heavy burden of perpetual maintenance and the securing to them of an enhanced value for their land, arising from government control, is all that should be done.

SAN PEDRO, CAL., has been selected by the California Deep Water Harbor Commission as a site for a harbor upon which the government appropriation of $3,000,000 is to be expended, of which sum $300,000 is immediately available. Thus ends the bitter local fight for the harbor between San Pedro and Santa Monica.

THE CAPE COD CANAL would be built by convict labor and as a public enterprise, if the bill of Willard Howland, now before the Massachusetts Legislature, should pass. Mr. Howland points out that all the private corporations proposing to build this canal have failed to raise the necessary capital and there is little prospect of future success in that line, says Mr. Howland. At the present time more than half of the 5,000 convicts whose labor is available, are now unemployed, and that it is costing the state $750,000 annually for their maintenance. He proposes to use only short-term prisoners on this work and would build the canal as a state enterprise. The scheme is approved by Superintendent of Prisons. Mr. Howland cites the employment of convict labor for the building of the English dockyards at Portsmouth and Chatham, the port at Plymouth and the breakwater at Fairfield, as examples of work of public benefit that could not be obtained through private enterprise. The proposition is likely to give rise to considerable discussion and is regarded with favor by many interested in the affairs of the commonwealth.

A NEW MOORING FOR LIGHT-SHIPS has been adopted by the Light House Board, and it is to be tried at the South Shoal Light-ship. The mooring chain is 200 fathoms long and is made of 1⅞-in. iron links. This chain passes to a large mooring buoy, which carries its weight, and then to the ship. This buoy carries a heavy coiled steel spring connected with the chain and taking up the strains put upon it by the seas. When the chain reaches the ship there is another spring rider, with 6-ft. play, adding to the elastic character of the mooring. In addition, the vessel is provided with 100 fathoms of a 12-in. hemp hawser to be bent upon the chain in very bad weather. It is believed that with this arrangement the light-ship can weather any storm.

THE U. S. MONITOR "PURITAN" arrived at the Brooklyn Navy Yard on March 15 with engines disabled. She left Charleston, S. C., on March 3, and three days later in the midst of a storm the engines broke down, and she was compelled to anchor off Southport, N. C. On March 10 she was taken in tow by the U. S. cruiser "Columbia," and brought to New York. The "Puritan" is one of the double-turreted slow-speed monitors which have recently been completed although they were designed over 20 years ago. They seem admirably adapted for coast defence, being provided with the heaviest armor and armament, but they are very uncomfortable boats in a storm on the Atlantic coast.

A 12-IN. GUN IN THE TURRET of the Russian warship "Cizoi Veliky" exploded at Canea, on March 15, wrecking the turret and killing 15 men and wounding 21 others. The "Cizoi Veliky" was launched in 1895, and is protected by an armor belt, 17.7 ins. thick, 7 ft. deep and 247 ft. long, surmounted by a redoubt, 195 ft. long, protected by 5-in. armor. The two forward and after turrets are protected by 17.7-in. armor, and each contains two 12-in. guns of the Oboukhoff type. The accident occurred while the crew were engaged in gun practice and was caused by the breech of one of the guns not being properly closed. The turret was blown to pieces, killing all of the men and two officers inside, and in falling crushed others on the deck below. The "Cizoi Veliky" was 348 ft. long over all, 66 ft. 6-in. beam, 24 ft. draft, and had a displacement of 8,880 tons.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a derailment caused by a washout near Hazleton, Ind., on the Louisville & Nashville R. R., March 10. The south bound express from Chicago was running cautiously through a section of country which had been flooded by the overflow from White River, when the water-soaked embankment gave way and the engine, tender, baggage car and front end of the smoking car were derailed in about 6 ft. of water. Six men were killed.—— A train on the Missouri Pacific Ry. was derailed near Hiawatha, Kan., March 15, by striking a group of horses on the track. Three men were killed and five injured.

A BRIDGE ACCIDENT occurred March 9 on the St. Johnsbury & Lake Champlain R. R., at Cambridge Junction, Vt. The bridge was a Howe truss, built in 1874, of about 100 ft. span. A freight train broke in two and the two sections collided on the bridge, causing the fall of the span. No one was injured.——On March 5 a bridge on the Chicago & Erie R. R., near Foraker, O., gave way under a freight train and 14 cars went down.

THE NEW YORK & CONNECTING R. R. is a proposed line which is to extend from Port Morris, New York city, across the East River and through Long Island city to Bushwick, Brooklyn. Its object is to connect the Long Island R. R. with the New York Central R. R. and Harlem R. R. Mr. Oliver W. Barnes, M. Am. Soc. C. E., is Chief Engineer.

THE WATER SUPPLY OF BROOKLYN has been reported on at length by a special committee of the Manufacturers' Association of Kings and Queens counties. The committee recommends, among other things, the development to the fullest practicable extent of a deep-well system; daily chemical examinations of the water supply; the adoption of the meter system, the meters to be furnished and controlled by the city, and the rates to residences to be so adjusted as to make niggardliness in the use of water no object; investigations of future and distant sources of supply, especially with reference to the needs of Greater New York. One of the four members of the committee dissented from the recommendation regarding meters. Among those who appeared before the committee, aside from city officials, were Mr. Alfred T. White, ex-Commissioner of City Works; Mr. C. C. Vermeule and Mr. Wm. D'H. Washington, of New York.

A CONCRETE AND STEEL DAM is proposed by the Pioneer Electric Power Co., of Ogden, Utah, in connection with the power development described in our issue of Nov. 8, 1894. The dam will be about 400 ft. long and 60 ft. high, above the natural surface. It is proposed to build it of concrete masonry with the upstream face and top enclosed with steel plates and with three 1¼-in. iron rods embedded in the arches in horizontal planes 1 ft. apart, the rods to be parallel to and to extend along the whole length of the dam. There will be six concrete piers and two abutments, joined together at the top and the upstream face with semi-circular concrete arches. The piers will be 16 ft. thick and the arches will have a clear span of 32 ft. The vertical arches will be 6 ft. thick for the upper 60 ft., or down to the natural surface; 7 ft. thick for the next 25 ft., and 8 ft. to bed rock, some 5 to 15 ft. further down. The compressive strains in the arch-rings, by the formula, T = PR, will be 96, 106 and 120 lbs., respectively, for the 6, 7 and 8-ft. thicknesses. The steel plate facing will be bolted to the concrete. The plates will be ¼-in. thick, with splice joints, having single rows of rivets 3 ins. apart. The inner surface of the plates will be cleaned, but not painted; the outer surface is to be cleaned and have two coats of P. & B. paint. The general idea of this form of construction was suggested by Mr. Geo. H. Pegram, M. Am. Soc. C. E., Chief Engineer of the Union Pacific Railway, and Consulting Engineer to the Power Co. The plans were developed by Mr. Henry Goldmark, M. Am. Soc. C. E., and it is expected that construction will be started during the coming summer. Mr. C. K. Bannister, M. Am. Soc. C. E., is Chief Engineer of the Power Co. We are indebted to the "Engineering Record" for the above information.

ELECTRICITY FROM CARBON, WITHOUT HEAT, was the subject of a lecture delivered before the New York Electrical Society, on Feb. 24, by Mr. Willard E. Case. The apparatus was exhibited and operated a motor. In the cell used plates of tin and platinum formed the electrodes and carbon was oxidized by contact with unnamed chemicals. The claim was made that while the best electric plants now require 5 lbs. of coal per horse-power hour, by the Case process 0.2 lbs. of coal consumed gave an equal result. A thermometer applied at various times showed no heat generated in the process. Mr. Case stated that his experiment was without immediate commercial value, as the necessary chemicals were too expensive for general use; but his endeavor was to show that the potential energy of carbon could be transformed into electrical energy without waste, and he hoped that with further experiment some cheap agent could be found that would admit of the general and commercial application of the process.

THE NEW 1897 SPECIFICATIONS for sheet asphalt paving in the City of New York, call for an asphalt "equal in quality to that mined from the Pitch Lake on the Island of Trinidad, or from the Alcatraz Mine, Santa Barbara county, California."

THE GALVESTON HARBOR WORKS.*

By W. J. Sherman, Member Engineers' Club, of St. Louis.

Along the entire line of the Louisiana and Texas coast, from the mouth of the Mississippi to the Rio Grande, there is nothing to compare with the hand-locked harbor of 451 acres comprising Galveston Bay, and there has never been any division of opinion among the United States engineers as to the wisdom of deepening the entrance to this inviting harbor, capable of floating the navies of the entire world.

Between the northeast end of Galveston Island, and what is known as Bolivar Point—a peninsula extending southward from the main land—is the principal outlet for the waters of Galveston Bay. It is about three miles across from shore to shore, and through this channel ebb and flow the tides from the Gulf of Mexico, which, meeting the littoral currents which flow generally in a southwestern direction along the coast, deposit the sands which they carry and form what is known as the outer bar to Galveston Harbor; it is about 4½ miles out from the shore. This it is which interfered so seriously with navigation.

View of South Jetty Showing Five Derricks at Work Placing Granite Cover.

View of South Jetty, Galveston Harbor, 14,000 Feet from Shore.

The $77,000 expended prior to 1874 was wasted in a fruitless effort to deepen the channel by means of dredging, and when operations of this character were finally suspended, the natural depth of 12 ft. over the outer bar at mean low tide and 13 ft. over the inner bar had not been increased.

Then it was—in January, 1874—that the Board of Army Engineers adopted the famous gabionade project, which contemplated the construction of two gabionades, or training walls, for the ebb and flood tides; the one, from Bolivar Point seaward on the north side of the channel to the outer bar, and the other from the extreme northeasterly end of Galveston Island along the south side of the channel, in a direction generally parallel with the north gabionade, extending out from the mainland at Bolivar Point. Since the failure of the gabionade project these sea walls have been known as the north and south jetties, respectively.

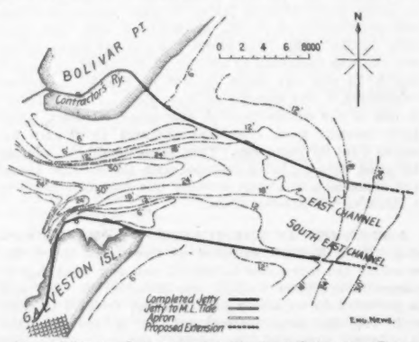
The Board of Engineers seemed to have been in doubt as to the proper height, distance apart and length of these two gabionades. They were to be training-walls for the under-currents which they theorized were the cutting agents on which they must depend for the deepening of the channel, but were not to materially interfere with the extraordinary ebb floods which at times occur in this region with such disastrous consequences to the improvements on Galveston Island, and cause the waters of the bay and the waters of the Gulf of Mexico to meet in the streets of the city. In the storm of 1875 the general level of the sea at Bolivar Point was 8 1-10 ft. above mean low tide, while the waters were said to have been banked up at the upper end of the bay to a height of 12 to 15 ft., caused by a stiff ten-days' blow from seaward. The damage was done when the wind shifted suddenly to the north and blew a gale, driving the waters over and around the island into the gulf.

These training-walls were not necessarily to rise above the surface to accomplish the purpose for which they were intended. They were expected more especially to arrest the sands which are carried along the coast by the littoral currents, and to prevent the deposits in the line of navigation. The area of cross-section between Bolivar Point and the end of Galveston Island was 155,611 sq. ft. The hydraulic mean depth was 17 3-10 ft, and the maximum depth was 42 ft. The mean daily tide at Bolivar Point is 1.1 ft.

Each jetty-wall was to consist of two rows of gabions, parallel and adjoining, and laid on willow mats, resting on the sand. The mats were placed in position by divers and weighted down with concrete blocks weighing about 230 lbs. each. The gabionade was built between two rows of guide piling, and the filling with sand was done after the gabions were placed in position. A gabion was nothing more or less than a woven pine stake-box, 6 × 6 × 12 ft., coated with cement inside and out and filled with sand, using larger size gabions for the deeper water.

The work done during the first season was largely destroyed by the great storm of 1875, and the gabions were badly broken and displaced. The Board of Army Engineers again convened to decide whether the gabionade system was a failure or not. The records show that after making minor modifications in the plans it was decided that the project should be carried on, and that it was so done until 1879, when the Board of Engineers convened once more for the purpose of passing upon the results attained after 7,332 ft. of the outer end of the north jetty had been built and some considerable portion of the inner ends of both north and south jetties. It was decided that, so far as the outer bar was concerned, the gabion plan was a failure, as no satisfactory results had been accomplished. The channel over the outer bar was no deeper; the moving sands carried by the littoral currents had not been arrested, and the gabionade itself was in very bad condition. So (Nov. 28, 1879) operations on the gabionade plan were permanently suspended, after having built 9,606 ft. of gabionade in the north jetty and a considerably less amount in the south jetty.

At this time we wonder why the engineers should have expected an increased depth over the bar without a training wall on both sides of the channel, especially when the depth on the inner bar, where the waters had been confined, had increased from 13 ft. up to 20 ft. It is likely, however, that the real reason for suspending operations on the gabionade was because of the unstable and unsubstantial character of the gabions themselves. It seemed impossible to keep them in position; the storms broke them open and washed out the sand filling, demonstrating the unwisdom of battling with the seas with structures so frail in construction. One curious feature of this experimental work was the fact that the gabions resting on mats seemed to sink into the sand as rapidly as those without, the settling of the gabions ranging from 3 to 7 ft. Another unpleasant surprise was caused by the failure of the gabionade to cover itself with the drifting sands, as was fully expected, and which, in fact, was the vital feature of the gabionade project.



Map of Harbor Improvement Work at Galveston, Tex

During the entire period of the writer's operations in Galveston Harbor, in 1892 and 1893, he failed to observe a single trace of the existence of any portion of these famous gabionades; and were it not for the statements of history and the Government's increased charges against the improvement from $70,000 in 1874, when dredging operations were abandoned, up to $[illegible] in 1879, when the gabionade project was permanently abandoned, one would hardly believe that such operations had ever been carried on there.

Once more the Board of Engineers convened, and the willow mattress project was the result. The Colonel of Engineers in charge said in his report: "It is now intended to build the jetties of brush and stone on a system which will undoubtedly succeed, for it has been applied to open sea exposure at the mouth of the Mississippi, where it has realized all anticipations and established a certain and economical way of constructing these jetty works on sand coasts." The top of the jetty was to be 5 ft. below the level of mean low tide; 12 ft. wide for the 4,080 ft.; then gradually sloping up to the surface, with the top width increasing up to 24 ft., at a distance of 10,220 ft. from the shore; from thence on with a uniform width of 24 ft. on top to a point 14,960 ft. from the shore, where began the end slope, 370 ft. long, downward to the bottom. The gabionade project was figured to secure 18 ft. of water; the mattress project 25 ft., and the latter project, which is the one being carried on to-day, is expected to produce a channel of 30 ft.

As soon as the mattress project was decided upon, Congress was asked for an appropriation of $500,000, and operations under the new project were vigorously carried on until 1886; but the work was confined to the south jetty, which was practically completed to the outer edge of the bar. The north jetty was left untouched and, naturally enough, there was no increased depth of water on the bars by reason of the operations during these six years, although a large amount of money had been expended, including a donation of $100,000 from the City of Galveston. At this time it was noticed that the mattress jetty was sinking and disappearing, and a line of levels run over the top of it showed a profile ragged and broken. Closer investigation revealed the fact that the rapacious sea-worm—the "teredo navalis"—was rapidly eating up the brush-work of the entire jetty. The danger of this seemed never to have been thought of. In 1892 and 1893, like the famous gabionades, there was little to indicate that such a thing as a completed mattress jetty had ever existed.

Again the Board of Engineers convened, and the present project, consisting of two practically parallel solid-rock jetties, was adopted. The surface of the jetties was to rise to a height of 5 ft. above mean low tide, to be 12 ft. wide on top, with natural slopes. The outer ends of the finished jetties were to be in 30 ft. of water and 7,000 ft. apart. The general lines of the gabionade and mattress jetties were to be followed. Excepting near the shore end of the south jetty—where the wall consisted exclusively of sandstone—the core of the jetty was to be of sandstone and the covering of top and slopes of granite blocks, increasing gradually in size from three-quarters of a ton at the shore end up to not less than ten tons, nor more than fifteen tons at the outer end. Sandstone was specified to weigh not less than 140 lbs. to the cubic foot.

In accordance with these plans, the work of jetty building was again begun, and for ten years has been carried on at a speed depending upon the liberality of the appropriations. At first the various portions of the work were handled by separate contracts, the extent of which was limited by the appropriations; but later the improvement was placed on the Sundry Civil list and a contract for the entire work was authorized and made. Under this contract the work for a number of years has been carried on at a cost of about one million dollars per annum. On June 30, 1895, the Chief of Engineers reported the total charges against Galveston Harbor as aggregating $5,590,970.40, and the estimate of amount needed to complete the project to be $1,700,000, making a total of nearly $7,300,000. Under active competition at the time of the letting of the present contract, the Government secured low prices, as follows, viz., $2.35 per ton for sandstone in place in the jetty wall, and $4.10 to $4.50 per ton (depending on the size) for the granite blocks. Sandstone had to be hauled 150 miles and the granite about 250 miles. In the prosecution of work under this contract, the successful contractors early discovered a very serious mistake they had made of guaranteeing to furnish sandstone weighing 140 lbs. to the cubic foot, when much of the Texas sandstone weighed but 128 lbs. It developed that it was practically impossible to carry out the contract. A mutual concession of 10 lbs. in weight for 10 cts. in price to a large extent overcame the difficulties at a sacrifice to the contractor of practically all the profit on the sandstone portion of the work.

At the end of the fiscal year, June 30, 1895, the south jetty had been extended seaward 32,829 ft., with all but 829 ft. entirely completed and 5,100 ft. of additional extension yet to make, while the north jetty had been built 22,500 ft. seaward, with 4,000 ft. incomplete. It will be noticed that the south jetty is about 10,000 ft. longer than the north jetty. The most of this difference is due to a long shore connection over the low-lands at the extreme northeast end of Galveston Island, and running in a general direction parallel with the coast instead of out to seaward. As a direct result of these operations, the depth of water on the outer bar was increased from 12 ft.—the natural depth—to 14½ ft. June 30, 1894, and to 17¾ ft.

*Condensed from the "Journal of the Association of Engineering Societies," Dec., 1896.

June 30, 1895. Unofficially, the writer learns that it is now about 20 ft. at mean low tide. Meanwhile, the inner bar has practically disappeared, there being 24½ ft. of water there June 30, 1894.

Although the jetties were gradually increasing the depth on the outer bar, it was decided some two years ago to supplement their work by dredging operations with a very powerful suction dredge, and a boat was built by the Government expressly for this purpose, and has since been put to work with very satisfactory results, as reported. Meanwhile, the jetty-walls are being pushed seaward to the 30-ft. contour line, where they will stop. Whether the 30-ft. contour will move further out with the diversion of the littoral currents to seaward, remains to be seen. The writer is inclined to believe that such will be the result, and that the jetties must eventually be extended still farther seaward, though the movement will likely be very slow.

Although there has been some settling of the stone jetties already constructed, necessitating moderate repairs, yet there is every evidence that the fourth project formally adopted by the Board of Army Engineers will be a pronounced success, even if the first three were complete and costly failures. It will provide at least 25, and with the aid of the powerful dredge-boat probably 30 ft. of water where naturally there was but 12 ft. over the outer bar. The cost of the work will have been excessive, due to the enormous amount of experimental work. But the advantages resulting to the people of Kansas, Colorado, Oklahoma, Indian Territory, Arkansas and Texas of deep water at Galveston will many times repay even this excessive cost. The commerce of the port of Galveston has increased from 863,196 tons in and out in 1877 to 1,211,354 tons in 1882, and 1,452,832 tons in 1895.

The work on the north jetty was begun and carried on for some time in practically the same manner as on the south jetty. There being no railroad on Bolivar Peninsula at that time, a car ferry was established and the trains of rock brought over from the railway yards of Galveston. This method, however, proving slow and expensive, it was supplemented by a barge line, which was established to a point on the mainland, near Houston, and deliveries of rock made directly into the jetty. With the aid of the barge line the work has progressed rapidly, and if the Government continues the appropriations at the rate of a million dollars per annum, we may hope ere long to read the announcement that this mammoth undertaking is finally completed, and that the Port of Galveston can be entered by any ship which floats.

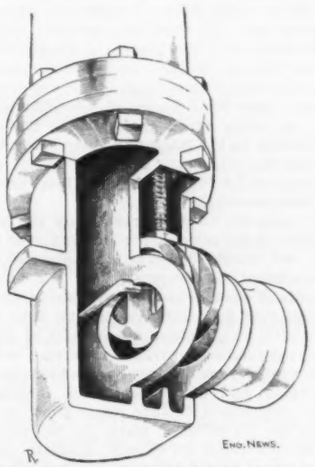
THE LOETZER DOUBLE-GATE COMPRESSION FIRE-HYDRANT.

This hydrant has been especially designed to meet modern requirements in a fire hydrant as fixed by careful study and long experience. The advantages claimed by the inventor, Mr. C. E. Loetzer, are summarized as follows: Unobstructed waterway; the total absence of rubber, leather or other perishable material in its construction; the use of bronze metal in the valve mechanism, stem, drip and all working parts; an arrangement avoiding the lodgement of sand or other injurious substances in the gates, seats or screw; and the general arrangement and operation of the hydrant; all internal parts being removable through the stand-pipe without digging.

As will be seen by inspecting the drawing shown herewith, this hydrant is closed against the water pressure by what is practically a double-gate valve, with bronze facing and seating, replacing the common rubber or leather used in this connection. The inlet is on one side of the gates, below the ground, and the outlet is from the other side to the nozzles above; and the water can only enter the stand-pipe by passing through both openings. When closed the pressure from the main only tends to force the gate still tighter against its seat, and the actual work performed by the stem is much less severe than in the ordinary type of fire hydrant. Great durability and little or no repair are claimed as special features, as the seats and gate-faces, the stem, stem-nut, wedge and even the drip-pipe, are made of bronze and cannot corrode; and no replacing by new material is required as when rubber or leather are employed. The drip is automatic, being closed and opened by the lifting or lowering of the gate; and the operation of opening and closing is such as to exclude the possibility of water-hammer. There is no pulling or pushing strain on the stem.

The internal arrangement is such that the diameter of the stand-pipe is only obstructed by the stem-pipe, and the free area of the stand-pipe, or its water capacity, is believed to exceed that of any other hydrant. The effect of this liberal capacity is to produce a smooth and steady nozzle stream and to reduce the loss from friction to a minimum. The area at the bottom of the 4-in. type of hydrant is equal to the combined capacity of two 2½-in. nozzles, and one 4-in.; the number and size of the nozzles is a matter of choice, and the diameter and free interior arrangement of the stand-pipe admits of any combination of nozzles desired.

There is, unfortunately, no uniform hose thread standard in use; the outside thread on 2½-in. couplings ranging from 3 to 3¼-in., and the number of threads per inch varying from 5 to 8. In this emergency the makers of this hydrant suggest that parties putting in new systems should



Perspective Sketch Drawn from Model of Loetzer Valve, Showing Gate Mechanism.

first consult the manufacturers and secure the benefit of their experience and records. By so doing standards can usually be adopted that will make connections interchangeable with neighboring towns and cities. The "National" hose coupling and thread, as adopted by the International Association of Fire Engineers, in 1879, is recommended by this firm, as being best adapted to ordinary conditions.

The hydrant here described is made by The J. O. Frost's Sons Manufacturing Co., of Towanda, Pa., and it is the invention of Mr. C. E. Loetzer, the general manager of this company. It is manufactured with 4 and 6-in. gate openings and fitted with from one to four 2½-in. nozzles, or one steamer and one or two 2½-in. nozzles. The prices for hydrants with 4-in. openings range from $31.50 for one 2½-in. nozzle, to $39 for four 2½-in. nozzles, or $38 for the one steamer and two 2½-in nozzles. For the 6-in. gate opening, the prices advance from $51.25 for two 2½-in. nozzles, to $55.25 for four 2½-in. nozzles, or $55.50 for the steamer and two 2½-in. nozzles. These are retail prices, with liberal discount to the trade.

The same firm also manufactures secondary gates for hydrants, with 4 and 6-in. openings, with iron body, but also bronze faced and seated. This valve is of the straightway, parallel seat, compound wedge type; the wedge being so made that friction between the gate valve faces is altogether avoided, as the first and last half-turn of the screw unlocks and locks the compound wedge. The valve-box supplied is also of a new design; telescopic, adjustable to any depth of trench and extra heavy, so as to withstand the severest service.

GOVERNMENT FREE SEED DISTRIBUTION, in 1896 cost $130,000, and $20,000 additional for expenses of distribution. The $130,000 bought over 20,000,000 packages of seed with a total weight of 1,200,000 lbs. As put up for distribution this seed would load 75 mail-cars, and it cost the Post Office Department about $100,000 to handle it. Secretary Morton, of the Agricultural Department bought the seed already packed ready for mailing, instead of in bulk as formerly, and introduced many economies. He said that the only further improvement that he could suggest upon the present practice is—The total abolition of the promiscuous and gratuitous distribution of seed by government agencies.

RAISING THE LEVELS OF THE GREAT LAKES.

By the courtesy of the Michigan Engineering Society, we are enabled to make the following abstract from the advance proofs of a paper, with the above title, presented to that society by Mr. B. H. Muehle, U. S. Assistant Engineer, of Detroit, Mich. The full paper will be published in "The Michigan Engineer's Annual for 1897:"

The demand for a deeper channel through the waters connecting the Great Lakes, to accommodate the larger vessels and a rapidly increasing commerce, was met, in 1892, by the project for the so-called 20 and 21-ft. ship channel between Chicago, Duluth and Buffalo. Dredging operations were commenced in the following year under liberal government appropriations. Supplemental projects followed for connecting this deep waterway with the Mississippi River and the Atlantic Ocean, and as one result the International Deep Waterways Association was organized. In this Association, says Mr. Muehle, there are evidently three elements pulling in opposing directions, while ostensibly working for one grand scheme of public utility. The Lake Carriers' Association stands in the middle, with the government engineers and money to back it; and on the one side is the Chicago sanitary canal, and on the other the advocates of a deep water canal around Niagara Falls. With the two latter enterprises tapping the chain of lakes at both ends, it is almost absolutely certain that the 20 and 21-ft. channels will be seriously affected.

Practically, all engineers of prominence agree that the construction of deep water channels to the sea will affect the lake levels; but they differ as to the extent to which this level will be affected, and this difference in opinion is principally caused by the insufficiency of water level records; with individual interests in rival projects entering as a secondary element.

The difficulty of reconciling the different propositions is increased by the prevailing low water in the lower lakes; and a downward movement has been continuous in these levels ever since 1886, with the exception of a slight rise in 1893 and 1894. The Lake Survey Plane of Reference, or the so-called high-water of 1838, was but a trifle over one foot higher than the monthly mean level of Lake Huron in June, 1886. Between 1838 and 1886 secular fluctuations in level have not been as regular as the believers in the 7-year rise and fall theory would like to demonstrate. In 1847 it was extremely low; 1852, high; 1855, low; 1859, high; 1866, low; 1871, high; 1872, low, 1876, high; 1879, low, and 1884-6, high. No records were higher than 1876 and 1886, and none lower than 1847. In the absence of accurate measurements and sufficient data, no certain cause can be found for these fluctuations.

Mr. Muehle suggests a new line of thought in the direction of a solution of the problem, confining himself, in this connection, to a study and description of the hydraulic conditions of Lake Huron and the Saginaw River. The Saginaw River drains an area of 5,800 sq. miles, and prior to government improvements its mouth was obstructed by a bar with but 8 ft. of water over it during the season of navigation, and less in winter. This outer bar was cut through, 200 ft. wide and 12 ft. deep, in 1869; in 1883 the channel was deepened to 14 ft., and since 1893 to 16 ft. The upper river channels have been dredged to 12 ft. deep since 1883. Forty years ago all the main tributaries of the Saginaw were navigable to small steamers, and the high stage of water continued through the greater part of the season of navigation, this latter generally commencing with a spring freshet, which sometimes rose 6 to 8 ft. above low-water mark at East Saginaw, 20 miles above the mouth of the river. But 25 to 30 years ago it was noticed that the spring freshets came in smaller volume; and since the high water of 1886 there has been no spring freshet worthy of the name.

The commonly accepted explanation of this change is the clearing of the pine lands by the enormous lumber industry developed along this river and its tributaries. Mr. Muehle admits that this denuding of the land may have some effect; but he believes that as this gradual diminution in flow has been coincident with the removal of obstructions in the Saginaw River, especially at its

mouth, this enlargement of the natural channel is primarily responsible for this gradual lowering of the water. In other words, all the water which discharges into the Saginaw River passes through the enlarged opening more steadily, continuously and quickly than it did or could do prior to the improvements. The result is seen in the dry beds of creeks which formerly held water enough to at least float a log. What is true of the Saginaw should apply equally well to other rivers emptying into Lake Huron, as there is no evidence that the hydraulic changes in this river are anomalous or peculiar features of this stream.

The levels of Lakes Michigan and Huron are generally described as being on the same plane, and they may be so considered for this discussion. Yet, as Lake Michigan has a length of about 340 miles to its only present outlet, the Straits of Mackinac, and Lake Huron is 230 miles long to its only outlet, the St. Clair River, there are some who believe that there must be a perceptible fall in both lakes, and that a line of precise levels across the lower peninsula of Michigan would demonstrate that these lakes are not on the same level. But both lakes may be considered as one water-basin with its outlet at Fort Gratiot. Along the shores of this basin at least 36 harbors have been constructed by removing obstructions from the mouths of navigable streams. The effect of the sum of the large quantities of water thus added to the volume of the lakes may be traced in a general way upon the chart of water levels; the seasons of high water following those during which the government improvements have been carried on. Thus the high water period of 1884-85-86 appears to have been caused by the extensive excavations made immediately prior or during that period.

We also find an artificial increase in the volume of discharge in the lakes, produced by enlarging the outlets of the lakes. This work commenced in 1874, at the Lime-Kiln Crossing, near the mouth of the Detroit River. Here, a ledge of rock with only 13 ft. of water over it was cut out to a width of 440 ft. and a depth of 20 ft.; the cross sectional area of the outlet was thus enlarged by over 3,000 sq. ft. This work was not completed until 1890 and the effect was so slow that it was not considered. Other deep-water way improvements have been made at the foot of Lake Huron, at St. Clair Flats, at Grosse Pointe and at the mouth of the Detroit River; and these improvements are, as a matter of fact, accompanied by a lowering of the levels of Lakes St. Clair and Huron, during the last two years, by an average of one foot below the level of 1894.

In the absence of any other reasonable, or even plausible explanation based upon facts, Mr. Muehle says that many engineers are now convinced that these excavations at the outlets of the lakes and connecting rivers are mainly responsible for the prevailing low stage of water, which affects even the levels in the improved channels to all possible causes for decreasing the volume of water in these lakes.

From these tables he concludes that the prospects for a general rise in lake levels, in the near future, are as remote as a return of spring freshets in the Saginaw Valley, and for similar reasons. The author then discusses the projects for artificially raising the lake levels, so as to restore the full depth in the 20 and 21-ft. channels. These projects include a dam at the head of the rapids above Niagara Falls; a timber and stone dam near Fort Erie, at the head of the Niagara River; similar dams at Grosse Isle; a dam at Peach Island, at the head of the Detroit River; contracting the upper end of St. Clair River by shutting off most of the minor channels, and a spur dam somewhere in the St. Clair River to check the strong current caused by a fall of 16 ins., between Fort Gratiot lighthouse and the mouth of Black River. The writer does not regard the hydraulic conditions of the Mississippi River and other western streams, which have been regulated by removable dams, etc., as being at all analogous to the conditions prevailing on the lakes and their connections. The annual fluctuations of the lakes do not exceed an average of 1.5 ft., and they are less than one foot in calm weather.

If dams are built for regulating the lakes they must be made permanent; but whatever they may cost, Mr. Muehle believes that this cost would be insignificant as compared with the far-reaching benefits of such an enterprise. But aside from the necessity of artificially raising the lake levels, so as to give, say, a simultaneous rise of two feet in every lake harbor, provision must also be made for future improvements involving additional changes in supply and discharge. These include among other enterprises further canal work at Niagara Falls, the diversion of water for private purposes at that point and the Chicago sanitary canal. This latter canal would take the Chicago River out of the "plus" table referred to and place it in the "minus" column. The effect of the continuous discharge of 10,000 cu. ft. per second in reducing the level of Lake Michigan is variously estimated; the canal engineers say the reduction would not exceed 0.2 to 0.4 ft.; the U. S. Engineers say 0.5 ft., and others make it still more; but Mr. Muehle believes that it would have a decided effect upon lake levels, and this canal must be duly considered in any project for artificially raising the level of the lakes. Mr. Muehle concludes by saying that if it is believed that the low-water in the lakes is caused by the tapping process here referred to, the only remedy seems to lie in plugging up these outlets again by a system of dams.

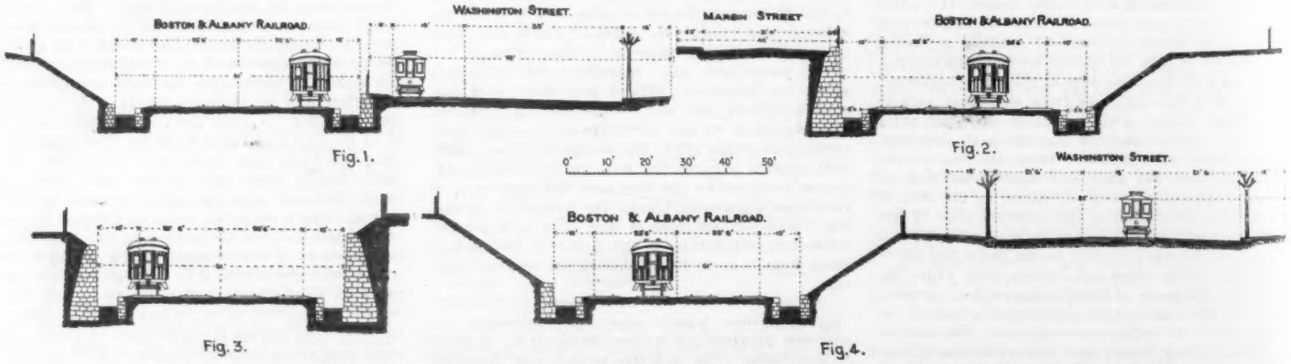
DEPRESSION OF THE TRACKS OF THE BOSTON & ALBANY R. R. AT NEWTON, MASS.

In a majority of cases in which work has been done to abolish grade crossings where a railway was built originally on the street level, the plan such an extent that present navigable depths are less than the 20 and 21 ft. designed. Mr. Muehle, in support of his theory, prepared two tables (given in the original paper), showing in a plus table the water added to the lakes by the improvement of tributaries, and in a minus table he gives adopted has been to elevate the railway tracks, but we illustrate herewith the method adopted at Newton, Mass., where the Boston & Albany R. R. is now at work on the depression of its four-track line below the normal surface of the ground.

The length of track to be depressed is 19,300 ft., and the maximum grade will be 23.76 ft. per mile (0.45%), while on the old line the maximum was 29 ft. per mile (0.55%). There are 9 public grade crossings and 3 private crossings abolished, and 17 bridges will be erected across the tracks. The width between retaining walls, or out to out of ditches, is 61 ft. The work has to be done without interruption to traffic, and there are about 161 train movements per day over this part of the line. The excavation is done by the railway company under the direction of the Road Master, Mr. Charles B. Lentell, small four-wheel dump cars as well as ordinary long flat cars being used to handle the material. The contractors for the masonry are Dwight & Daly, Ross & Fowler and Wellington & McCarthy. The steel bridges have been designed by the Bridge Engineer of the railway company, Mr. W. G. S. Chamberlain, and will be built by the Pencoyd Iron Works, A. & P. Roberts Co., of Philadelphia, Pa. The work of constructing the temporary roadbed for the railway was commenced in March, 1896. The work on the depression of the tracks was commenced in July, 1896, and it is hoped to have it completed by December, 1897. The cost will be about $2,500,000, of which 65% will be paid by the railway company, 25% by the state and 10% by the city. The amount expended during the year ending June 30, 1896, was $263,399, of which sum $159,624 were paid for land and land damages. The work is in charge of Mr. William Parker, Division Engineer, under the direction of Mr. Walter Shepard, Chief Engineer, B. & A. R. R.

As will be seen by the accompanying cross sections, Figs. 1, 2, 3 and 4 (which are reproduced from plates in the report of Mr. Henry D. Woods, City Engineer of Newton, for the year 1895), the line is in a shallow cut, with retaining walls at some parts and earth slopes in others. Fig. 5 shows a typical cross section of the retaining wall, and Fig. 6 shows the arch for the Hyde Brook drain. These two figures are taken from blueprints furnished by Mr. Shepard. In order that this work may be carried on expeditiously and safely, the city has provided land for a temporary location of the tracks for a part of the way, which prevents any serious interruption to the traffic.

Among the arguments originally urged against the plan for depressing the tracks, were the objections of the traveling public to passing through a deep cut with side walls, and the difficulty of doing the work without interruption to traffic. To meet the former objection the mayor, Mr. Bothfield, in 1895, suggested the use of side slopes to the cut, while to meet the latter he proposed to give the railway a temporary location on the strip of land between Washington St. and the railway, as noted above. Slopes on the south side of the tracks, wherever practicable, as well as on the north side, were insisted on by the city and accepted by the company. The widening of Washington St. (parallel with the railway) was undertaken at the same time, and the land between this street and the tracks will be formed into a



FIGS. 1, 2, 3, 4.—SECTIONS OF TRACK DEPRESSION TO ABOLISH GRADE CROSSINGS AT NEWTON, MASS.; BOSTON & ALBANY R. R.

slope, so as to reduce the walled sections to a minimum. The following is an extract from the annual report of the City Engineer:

In order to raise the streets over the railway as little as possible, and cause the least damage to the adjacent land, the railway endeavored to depress the tracks as far

as possible without interfering with the matter of drainage. It was, therefore, decided to lower the brooks which crossed the railway as much as practicable, and thus limit the amount of the possible depression of the tracks.

In order to depress the tracks and have ample room for the removal of snow, it was decided to place the ditch wall (that is, the outside wall of the drainage ditch on either side of the tracks), 10 ft. from the nearest rail. The railway sections for depressed tracks are 3 ft. wider than the present construction. It was also found necessary, in order to utilize the present stations and to avoid as much rock blasting as possible, to move the tracks somewhat to the north in various places. The maximum movement is some 10 ft., from Mt. Vernon to Walnut St. This necessitated taking rather more land on the north side of Washington St. In places the slopes and temporary tracks will take up

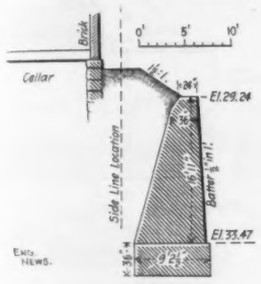


Fig. 5.

Fig. 5.—Cross Section of Retaining Wall on Washington St., Newton, Mass.; B. & A. R. R.

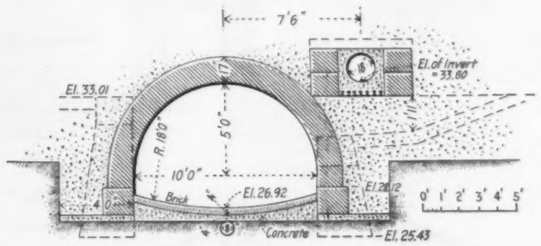


Fig. 6.

Fig. 6.—Arch of Hyde Brook Drain Under the Boston & Albany R. R. at Newton, Mass.

about all the present width of Washington St., and while the work is being done on the railway, street traffic will all have to be on the widened portion of the street. For this reason a temporary sidewalk, 6 ft. wide, will be built on the north side of the street, which will eventually be widened out to 12 ft. when the work is completed.

When completed the roadway on Washington St., from West Newton to Hall St., will be 61 ft. wide, with a 12-ft. sidewalk on the north side. Where the railway is contiguous to the street the electric cars will be on the south side, and there will be a 6-ft. walk next to the railway fence for the use of the travelers on the electric cars. Where there are building lots left on the south side of the street there will be a 12-ft. sidewalk also.

Besides this work at Newton, the railway company has made a separation of grades at Natick, Mass., and other points, while the work at both Newton and Natick has necessitated the construction of new freight yards at these places. As an instance of the cost of work of this kind, the railway company's report for the year ending June 30, 1896, states that the total cost for eliminating grade crossings during the year was $686,624. The charges against the earnings which were credited to grade crossings were $130,000 for 1895 and $170,000 for 1896, or a total of $300,000 for the two years. About 339,385 cu. yds. of gravel have been used in raising the tracks at various places, and for other improvements, at a cost of $135,574.

TESTS OF RESISTANCE OF VEHICLES ON COMMON ROADS BY THE U. S. DEPARTMENT OF AGRICULTURE.

In view of the improvements in road making, the introduction of asphalt paving and the change in the construction of vehicles, the U. S. Department of Agriculture has deemed it desirable to conduct a new series of experiments to determine the value of tractive force in the case of vehicles and roads now in use. These experiments have now been completed and are reported upon in full by Mr. Samuel T. Neely, Assistant Engineer in the Office of Road Inquiry, and they are published in Bulletin No. 20 of this office. An abstract of this bulletin follows:

The first experiments were made on the roads of the U. S. Road Exhibit at the Cotton States and International Exposition in Atlanta, in 1895, consisting of a modern macadam, a sand and an ordinary dirt road. The manner of making these roads is described and the traction experiments were made with a heavy farm wagon loaded with cotton bales. The amount of pull exerted at any time was indicated by a specially designed tractometer, here illustrated. In this device the amount of force exerted by the team was weighed by the spring S, in compression, and was indicated on the arc A by means of the pointer P. The smaller spring was sufficient for all forces below 600 lbs.; and the larger spring came into play after this mark was reached. The arc shows above the backs of the horses and was marked in large figures. No precaution was taken to check or lessen the oscillations of the index arm beyond that of making the parts fit snugly. There was thus no lost motion and all oscillations recorded the variation in the amount of pull. Though these conditions made it impossible to read the scale accurately, it indicated the true state of affairs, which was as follows:

On the smoothest possible macadam road surface the force of traction was not constant, but changed continually within a range of 50 lbs.

On the ordinary dirt road the force varied from absolute zero to 700 lbs. (in a gross load of 3,000 lbs.), becoming in effect a rapid succession of violent jerks.

On heavy grades in the case of the smooth road, the force was more nearly constant. On a smooth road the force necessary to start a load was four times as great as the force required to

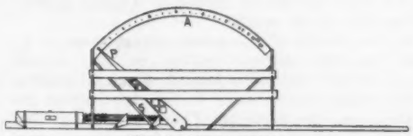


Fig. 1.—Tractometer.

draw the load at a uniformly slow pace when started, and was one-tenth the gross load. The force required to start a load on a dirt road was about one-fourth the gross load, or not greatly in excess of the upper limit of the tractive force when the wagon was in motion. From these observations the following conclusions were drawn:

A team harnessed in the ordinary way is subjected to a continuous jerking motion, which on even the smoothest country road is enough to greatly increase the fatigue. On a dirt road in bad condition this jerking motion becomes a succession of heavy blows transmitted to the animals by means of the collar. The fatiguing effect of these blows is probably double that of a steady pull equal to the maximum figure reached in the oscillations, and they further bruise the shoulders of the team. Starting a heavy load is also equivalent to a violent blow, as the driver ordinarily draws his team well back and then urges it suddenly forward against the collar held by rigid traces.

The smoother the road the more nearly constant will be the tractive force and the less the fatigue for the same amount of work. And if a load four times as great can be drawn over a smooth road as over a rough one, by exerting the same amount of force, then a team can haul four times as much in the same time over the smooth road and suffer less fatigue in the operation. Mr. Neely thinks that some method should be adopted for making an elastic connection between the wagon and the team, thus gradually transmitting the shocks at the wheel rims to the team. He says that at Atlanta a team of small mules readily drew 12 bales of cotton of 500 lbs. each, on a heavy Studebaker wagon up a 10% grade on the macadam road, with the tractometer indicating a pull of 1,000 lbs. The same team was completely stalled in going down the 6% grade on the sand road, with an indicated pull of 1,900 lbs. Nine bales of cotton were removed before the team could be again started. The driver refused to venture upon the dirt road with the 12-bale load.

To demonstrate the practical advantage of wide over narrow tires, the following test was made: A piece of clay road was made thoroughly wet, and over one portion a heavily loaded wagon with 2-in. tires was rapidly drawn, and over the other portion an equally heavy wagon with 4 and 5-in. tires was drawn the same number of times. In the latter case the front axle was shorter than the rear axle, so that the wheels did not run in the same track. The result was that the narrow tire cut the road into ruts several inches deep, while the broad tires rolled the road into a smooth surface. The tractometer showed that twice as much pull was necessary to draw the same load over the half-road cut by the narrow tires.

In order to obtain results which would be accurate and of scientific value, a tractograph was devised to record the pull automatically. This apparatus was similar in principle to that used in securing indicator diagrams. A long arm, holding a pencil at the end, was attached to the end of the piston which previously moved the pointer in the tractometer. The pencil point rested on a revolving cylinder extending along the wagon pole, and the cylinder was revolved by means of the gear, shown in the cut, driven directly by one of the front wheels of the wagon. A single long spring was substituted for the two short springs previously used.

Any pull exerted at the double-trees would compress the spring and cause the pencil to move forward along the cylinder, and as the cylinder revolved as the wagon moved forward, a continuous record of the force exerted was thus recorded on the paper. The tractograph was graduated in pounds by placing weights on a platform connected to the double-trees by a rope and pulley. The scale was made to 10,016 intervals up to 1,200 lbs.; and from this data sheets were ruled and spaced to 1,016 pulls. As the cylinder revolved once in a forward movement of 1,316 ft., the sheet was ruled transversely into spaces corresponding to 100 ft.

Experiments were made with this instrument and diagrams are given for results obtained on a level asphalt street, on a level macadam, a level dirt road and on a macadam road on a 10% upgrade. The two first show a generally even range of oscillations, with an average pull of about 50 lbs. in the first case and 100 lbs. in the second. The dirt road was dry, smooth and firm; but the pull runs up from 100 to 500 lbs. with rapid changes, and the general result is a draft of about 2½ times that required on a macadam road. In the case of the hill the record shows very wide oscillations caused by

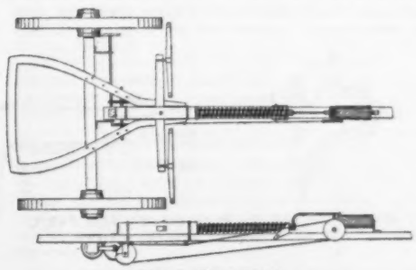


Fig. 2—Tractograph.

the fact that the team required constant urging. It required nearly seven times as much effort to draw the load up the 10% grade as on the level highway.

The tractive force is taken as signifying the force required to draw one ton of 2,000 lbs. On this basis the following is the record for these four experiments:

Road.	Tractive force.
Asphalt, level, poor condition	26 lbs.
Macadam, level, good condition	38 "
Dirt road, level, good condition	96 "
Macadam, 10% up-grade	236 "

Mr. Neely compares these with the results for the best macadam roadways as tabulated by Mr. Rudolph Hering, M. Am. Soc. C. E.:

Authority.	Tractive force.
Navier	45 lbs.
McNeill	46 "
Rumford	50 "
Gordon	37½ "
Morin	32 "
Office of road inquiry	38 "
Average	41 lbs.

The following general results are obtained from the experiments made by the engineers above mentioned:

The force of traction varies universally as the diameter of the wheel, and increases with the speed, upon hard roads, but is not in proportion with the velocity. The width of tires is found to have no effect on the traction on hard roads; but this width has a very decided effect upon the condition of the road surface and on the cost of maintenance. The effect of inclination of surface is a matter of mathematical computation and can always be figured by the following formula:

$$R = F + a W \text{ where}$$

F = Force required to draw the load on a level.
a = The grade expressed by a fraction.
W = The weight of the load in pounds.
R = Force required to draw the load up the incline.

An appendix to the bulletin contains various tables taken from Sir John McNeill, Morin, Mr. Rudolph Hering and from experiments made by the Office of Road Inquiry.

OUTFALL SEWER AND SEWAGE FARM AT SALT LAKE CITY, UTAH.

(With full-page engraving.)

Among the most important of the new public works of Salt Lake City are the gravity intercepting sewer and the sewage farm, which were undertaken to prevent the pollution of the Jordan River, and were referred to in the "Notes of a Transcontinental Trip" in our issue of Oct. 15, 1896. The sewer was described and illustrated in our issue of Jan. 4, 1894, but in Fig. 1 we show a part of the deep trench. The sides and bottom of the sewer are of concrete, the material being rammed outside of a form supported by collapsible centers. The two side pieces of each center are hinged to the bottom piece and are folded inward when the top brace is removed. This brace has been removed from the front center shown in the cut. The arch of the sewer is built of native Utah (yellow) brick, and as this is poor and porous, the outside of the arch was well plastered with cement mortar. The sewer is 36,151 ft. long, with diameters as follows:

38-in.	200 lin. ft.
42-in.	5,133 " "
48-in.	12,868 " "
64-in.	17,950 " "
Total	36,151 lin. ft.

The sewer was planned to extend to the intersection of Ninth South and Fourth East Sts., but the City Council ordered the work stopped at the intersection of Fifth South and State Sts., on account of lack of funds. About 200 ft. of the 38-in. section was constructed with a gate placed at the lower end, where it connects with the 42-in. section, and this is used as a flush tank. There are 20 miles of laterals connected with the gravity sewer, and the number of house connections is 912.

The volume of sewage entering the gravity sewer is 2,500,000 gallons in 24 hours, and the volume of ground water entering is 1,500,000 gallons in the same time, making a total of 4,000,000 gallons per 24 hours.

Where the sewer passes under North Temple St. there is a drop manhole connecting with the North Temple St. aqueduct, which is shown in Fig. 2. The aqueduct has a concrete lining at this point, and is fitted with an iron gate hinged to the sides of the channel and raised by chains wound on a transverse bar operated by gearing. The channel is 10 ft. wide on top. The gate is shown raised to its normal position to allow all the water to flow down the aqueduct. When it is desired to flush the sewer or to carry off storm water, the valve is opened by the hand wheel, and the gate lowered, backing up the water so that it flows through the grated opening to the drop. The water is not turned into the sewer from the North Temple St. aqueduct except for flushing, and during high water, then the amount turned in is about 15,000,000 gallons in 24 hours.

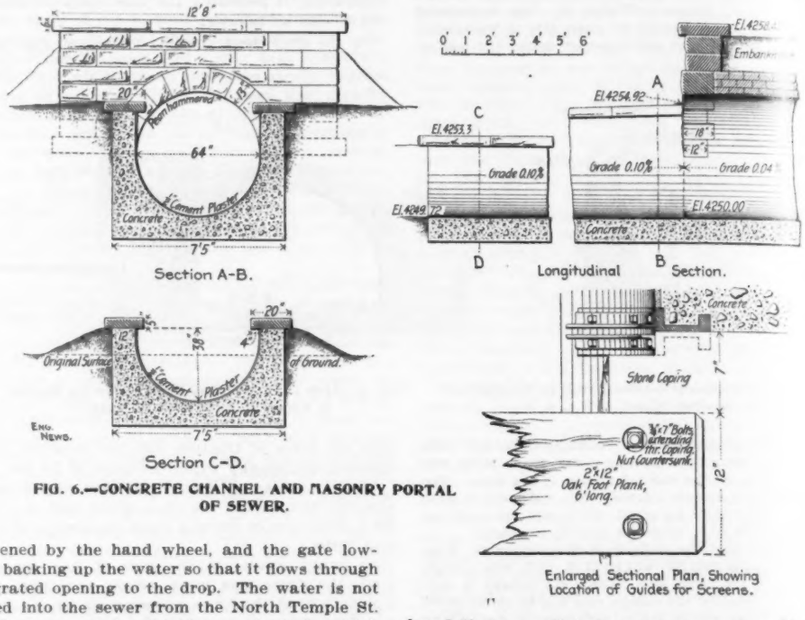


FIG. 6.—CONCRETE CHANNEL AND MASONRY PORTAL OF SEWER.

At the mouth of the sewer tunnel there is an open concrete channel leading to the sewage farm. This is shown in Figs. 3, 4 and 6. In Fig. 3 the tunnel curves away to the right, along the valley, near the foothills. Fig. 4 is looking from the tunnel portal to the sewage farm, the channel connecting with the ditch where the white line of the coping ceases. Fig. 5 shows the construction of the channel and sewer portal.

Sewage Farm.—When this plan of disposal was first decided upon it was thought that farmers would be willing to take the sewage for irrigation, since all land here for cultivation must be irrigated. The farmers, however, were afraid of it, mainly from ignorance, thinking that it would damage the crops, clog the ground and be otherwise injurious. Proposals for the right to use the sewage were advertised for, but the only bid received was one by which the bidder asked to be paid for taking the sewage. This condition of affairs was discussed in our issue of Nov. 7, 1895. The call for proposals estimated the sewage discharge at about 1,500,000 gallons in 24 hours, with perhaps an equal amount of ground water. The volume of water turned in at the North Temple St. aqueduct connection, above mentioned, would vary with the season, and during high water in the river the combined volume of the aqueduct water, ground water and sewage may equal the full capacity of the sewer at the point of connection, while at other seasons there may be but little if any water turned in here. There is a large area of unimproved land near and below the outlet of the sewer that is without water for irrigating purposes, which could be reclaimed by turning the sewage upon it in a proper manner. The city had purchased 75 acres of this unimproved land at the sewer outlet and offered the use of this free to the contractor. When it was found that no satisfactory arrangement could be made for handling the sewage by contract, it was decided to undertake cultivation by sewage irrigation on the city's land, as a means of educating the people to the advantages of the use of sewage for irrigation, and it is confidently expected that the results will be so satisfactory as to destroy the prejudice against the use of sewage and lead the farmers to take it for their land, and it is considered that the conditions here are specially favorable to its use since all land for cultivation must needs be irrigated. The original farm comprised 75 acres, but additional land has been acquired, and there are now 200 acres, of which 90 acres have been plowed. The land extends to the Jordan River, and the main ditch is carried to the river, so that when the sewer is running full with water from the aqueduct, the flow can be sent directly along the ditch to the river, without being turned upon the land at all. A plan of the farm is shown in Fig. 5, and it will be noted that at one point the property is practically separated, since it meets only at a corner. Here it has been necessary to obtain right of way for the sewer across the corner of the adjoining property.

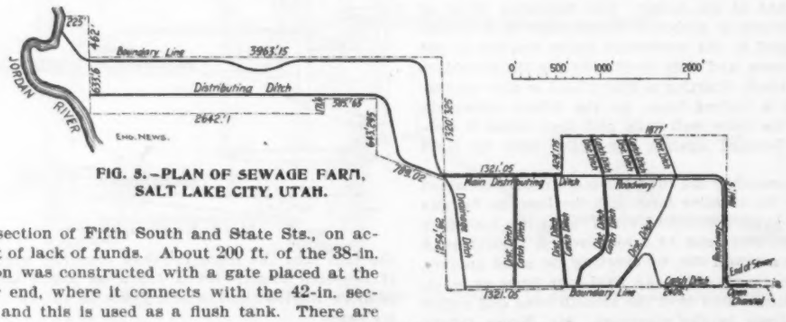


FIG. 5.—PLAN OF SEWAGE FARM, SALT LAKE CITY, UTAH.

The gravity intercepting sewer tunnel ends at the sewage farm in a portal of Park City yellow sandstone, from which an open cement-lined conduit leads to the main ditch, as shown in Figs. 3 and 4, already referred to. The details of this portal and conduit, or channel, are shown in Fig. 6. Parallel with the main ditch is the secondary or distributing ditch from which the sewage flows through furrows plowed at right angles to the ditch. In Fig. 7 the main ditch (with one of the gates opening to the secondary ditch) is just beyond the fence, while the two men in the foreground are standing on opposite sides of the secondary ditch. Culverts of Utah sewer pipe connect the main and secondary ditches, and are closed by gates in the side of the main ditch. The construction of these culverts and gates is shown in Fig. 8. At these culverts the main ditch is lined with concrete, and faced with cement plaster, a groove being formed in the face of the concrete to receive the flat iron gate, the gate being guided by studs embedded in the concrete. A yoke is embedded in the top of the concrete slope,

and carries studs or catches to hold the gate in any desired position. Vertical iron rods are built into the concrete floor of the ditch at the opening, to hold movable stop planks, and brick paving is laid for a short distance adjacent to the concrete lining.

The sewage farm has been in constant use since the sewage was turned into the gravity sewer, on July 11, 1896. It then being so late in the season no crops were planted, except about five acres of corn for fodder. It is the intention to improve the farm by erecting buildings, planting shade trees along the roadways and planting an orchard on the land which is too high for surface irriga-

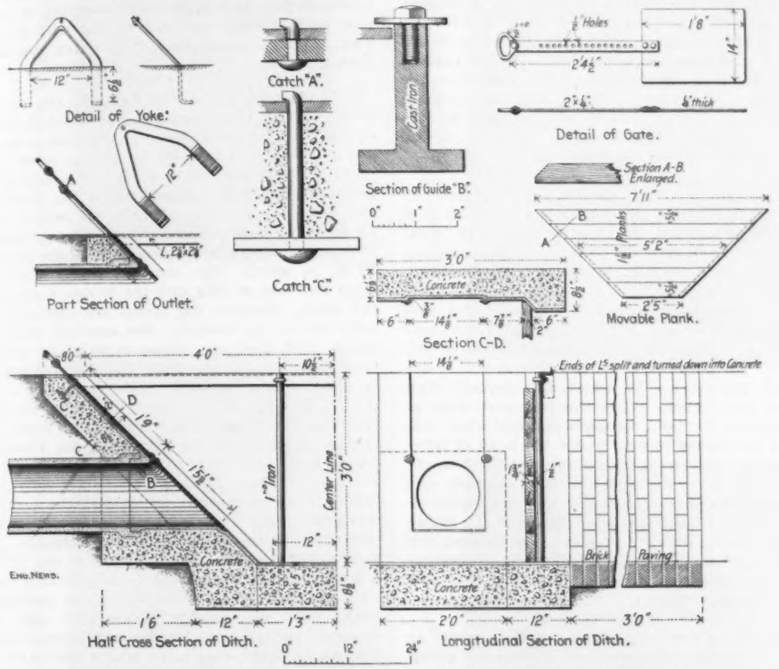


FIG. 8.—DETAILS OF CULVERTS BETWEEN THE DITCHES ON SEWAGE FARM.

tion (about 6 acres). Next season the plowed land will be utilized for raising crops.

The land is prepared for the sewage by throwing it into ridges, about 3 ft. apart, with a 14-in. lister (a double mold-board plow that throws the dirt both ways) which forms a furrow about 12 ins. deep between the ridges. About 4 ins. in depth of sewage is turned into the furrows from the head ditch and allowed to run until the land is thoroughly soaked, when it is changed to another set of furrows. By the time the sewage reaches the catch ditch at the lower side of the land, it is clear. It then runs into the drain ditch and thence to the Jordan River. The land is watered every day for three or four days, then the watering is discontinued and as soon as the ground is dry the lister is run through the ridges, splitting them, filling up the old furrows and forming new ones. The main distributing ditch has a bottom width of 3 ft.; it is 3 ft. in depth and has slopes of 1 to 1. The grade is from 0.1 to 0.16%. The small distributaries are 2 ft. wide and have grades of from 0.1 to 0.2%.

The works have been planned and carried out by Mr. F. A. Doremus, M. Am. Soc. C. E. (until recently President of the Board of Public Works), and Mr. F. C. Kelsey, City Engineer, and we are indebted to the latter for photographs and information made use of in the preparation of this article.

THE DECISION ON THE BOWERS HYDRAULIC DREDGE PATENTS.

We noted in a recent issue the announcement of a decision by the Circuit Court of Appeals for California upon the Bowers patents on hydraulic dredges. A complete copy of this decision is now before us and contains matter of much interest to manufacturers and users of dredging machinery. The decision is too long for reprinting entire; but the following extracts will show about what the Bowers patents in controversy (Nos. 318,859 and 355,251) are held to cover:

The fundamental elements of the complainant's patent 318,859, and of the machine covered by it, are: A boat and excavator capable of working with a side feed, a non-rotating suction-pipe, an exhausting and discharging apparatus, a discharge pipe, a self-contained pivot or center of oscillation, on which the boat swings from side to side while it is working, devices for swinging and for working the machine from side to side, devices for moving the machine ahead preparatory to a new cut, a floating discharge pipe when the spoil is to be transported over water, a submerged discharge pipe when the spoil is to be carried across a navigable channel without impeding navigation, and an outer stationary section of discharge pipe when the spoil is to be carried over land.

The claims of this patent found by the court below to have been infringed by the defendant are as follows:

10. A dredge-boat having a self-contained pivot forming a center of horizontal oscillation, with devices for swinging and working said boat upon said pivot, in combination with a suction pipe, exhausting apparatus and rotary excavator.

16. A dredge-boat and oscillating section of a conduit discharge flexibly joined to a non-oscillating section to allow said boat to feed forward and said oscillating section to swing upon the flexible joint connecting said oscillating and non-oscillating sections.

25. A discharge pipe consisting of a series of sections flexibly joined together and supported by floats, in combination with a dredger having a rotary excavator.

53.—The combination, with a non-rotative suction-pipe, of a rotary excavator having an inward delivery through said excavator.

54. The combination, with a dredge-boat and non-rotative suction-pipe, of a rotary excavator having an inward delivery through said excavator.

59. A rotary excavator with inward delivery, in combination with a non-rotating suction-pipe, mounted upon strong trunnions or equivalent joints, to permit the excavator and outer end of the suction-pipe to be raised and lowered to suit the depth at which it is progressing.

The complainant was the first to invent not only a rotary excavator having an inward delivery through itself to a suction-pipe, but also of the combination of such an excavator with transporting and discharging devices by means of which hard material in place can be severed, lifted, and continuously carried over water or land to any desired place of deposit.

He is therefore justly entitled to be regarded as standing at the head of the art in those respects, and to a broad and liberal construction of his claims thereto. So regarding him, the objections of the appellant to the validity of the complainant's patents are not well taken.

When the complainant claimed in claim 10 of his patent 318,859: "A dredge-boat having a self-contained pivot forming a center of horizontal oscillation, with devices for swinging and working said boat upon said pivot, in combination with a suction-pipe, exhausting apparatus and rotary excavator," he was not claiming a result, which, of course, he could not do. Nor did he thereby limit himself to any particular form of construction of the several devices therein mentioned. What he there claimed, and what he, as the first inventor of any combination that would accomplish the desired result, had a right to claim, was the combination of a dredge-boat, itself containing a pivot forming a center of horizontal oscillation, with devices for swinging and for working the boat on the pivot, a rotary excavator for the severing of the material in place, a suction-pipe for its receipt and transmission to the exhausting apparatus, and the latter for the transportation and discharge of the spoils to the desired place of deposit. The record shows that the complainant was the first to combine those elements at all, and that the functions performed by his machine so constructed were entirely new. Hence, he had the right to make the broad and generic claim embodied in claim 10, without any limitation as to the form of construction of the particular elements, and all subsequent machines which employ substantially the same means to accomplish the same result are infringements, notwithstanding the subsequent machine may contain improvements in separate mechanism which go to make up the machine. (Authorities supra, and McCormick v. Talcott, 20 How., 402; Railway Co. v. Sayles, 97 U. S., 554; Clough v. Barker, 106 U. S., 166; Valve Co. v. Valve Co., 113 U. S., 157.) Of course, it remained open to any subsequent inventor to accomplish the same result by substantially different means.

Claim 16 of the complainant's patent 318,859 is a combination of a dredge-boat, a floating-pipe, and land-pipe, and a flexible joint between them. The same combination was, for the first time in the history of the art, made by the complainant July 13, 1864.

Claim 25 is for a combination of a discharge pipe consisting of a series of sections flexibly joined together, floats for supporting the pipe on water, and a dredger having a rotary excavator.

Claim 53 is for a combination of a non-rotative suction pipe with a rotary excavator having an inward delivery through itself.

Claim 54 added to the combination covered by claim 53, a dredge boat; and claim 59 added to the combination covered by claim 53, trunnions or equivalent joints to permit the excavator and outer ends of the suction pipe to be raised and lowered to suit the depth at which the work is progressing.

Claims 13, 17 and 18 of the complainant's patent 355,251, found by the court below to have been infringed by the defendant, are as follows:

13. In combination, a dredge-boat, exhausting device, telescoping suction-pipe, and a rotary excavator provided with detachable cutting edges.

17. In combination, a dredge-boat, exhausting device, telescoping suction-pipe, and a swinging section of discharge-pipe flexibly joined to the boat and to an outer stationary section, to allow said boat to feed forward and said oscillating pipe to swing on the joint connecting the oscillating and non-oscillating sections.

18. In combination, a dredge-boat, exhausting device, telescoping suction-pipe, rotary excavator and a swinging section of discharge-pipe flexibly joined to the boat and to an outer stationary section, to allow said boat to feed forward and said oscillating pipe to swing on the joint connecting said oscillating and non-oscillating sections.

The element here introduced that is not embraced by any claim of patent 318,859 is a telescoping suction-pipe.

While the telescoping suction-pipe was old, the record shows that the complainant was the first to combine it with the other elements of the several combinations specified in claims 13, 17 and 18 of patent 355,251.

In no just or proper sense can any of the combinations described in the complainant's claims involved on this appeal be said to be mere aggregations, for the reason that the result is the product of the combination, each element affecting the action of the others, and all of them co-operating in the one result of severing by the forward and side action of the machine the material in place where it is not wanted and depositing it in another place where it is wanted. The flexible joints of the floating discharge-pipe and the vertical anchors or turntable, as the case may be, permits the movement of the machine from side to side as well as forward, and in combination with the other elements specified, makes possible the continuous cutting and lifting of the material in place and its continuous transportation to the desired place of deposit. No combination of elements that so operate can be regarded as a mere aggregation, for each one has a direct influence upon the action of each of the others, the result necessarily being the product of the combination itself and not a mere aggregate of several results, each the complete product of one of the combined elements.

Any of our readers interested in this subject who desire complete copies of the decision can probably obtain them by applying to Mr. Bowers' attorney, Mr. John H. Miller, Mills Building, San Francisco.

THE LONG DISTANCE ELECTRICAL TRANSMISsion plant at Fresno, Cal., installed by the General Electric Co. several months ago, carrying current from a waterfall on the San Joaquin River, 35 miles distant, is reported to be running with entire satisfaction, having given no trouble whatever since the start. The load at present consists of 5,000 incandescent lights and 410 HP. in motors.

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We noted some time ago the index to engineering literature which had been undertaken at the University of Wisconsin; but the undertaking is being pushed so conscientiously and promises to be of such value to engineers generally that we think it worth while to again call the attention of our readers to it. The index forms a part of the "Wisconsin Engineer," a quarterly magazine published by the engineering schools of the University. The number for January, 1897, contains over 30 solid pages of references to articles, and the periodicals indexed include all the principal American and foreign engineering journals. The arrangement is an alphabetical one, and it is not divided into departments, so that there is no opportunity for doubt as to the proper head under which to look for a subject. The price of the magazine is only $1.50 per annum, which places it within the reach of any engineer who has use for an index to current engineering literature.

The policy of fostering railways and other public works by granting government subsidies to private corporations is one which has undoubtedly hastened the settlement and development of every country that has adopted it. On the other hand the policy has been largely responsible for the creation of enormous public debts, for the carrying out of enterprises that ought not to have been undertaken, and in many instances for corrupt connections between government officers and the promoters of subsidized corporations. In the United States, experiments in government aid to works owned by private corporations have been chiefly confined to the separate states. The land grants and other gifts to the Pacific railways are about the only cases in which the national government has ventured upon this policy since the days when the nation was in its swaddling clothes.

Across our Northern border, however, Canada still continues to grant subsidies, although the heavy load of debt under which the Dominion is laboring makes its best statesmen exceedingly anxious to call a halt and put a stop to the creation of any new drains upon the treasury. But the subsidizing policy is, like other bad habits, easier to contract than it is to throw off. Subsidies always attract a swarm of promoters and concession hunters, who in time are able to exert no small influence in a political way to prevent a change of policy. The voice of the few whom a particular subsidy will benefit, moreover, is almost always louder and more effective than the voice of the millions to whom the subsidy means only a trifle added to their load of taxation.

Indications are not wanting, however, that the voice of the Canadian taxpayers will before long make itself heard. It is said that during the past six months applications for subsidies amounting to over $50,000,000 have been made upon the Canadian Government. One of the latest enterprises to plead for government support is the Georgian Bay canal scheme, which wants $250,000 a year for 20 years. It will be remembered that the report of the United States Deep Waterway Commission, published in our issue of Feb. 11, 1897, expressed the opinion that this route would offer no advantages whatever over the present lake route, if it were to be built and opened to free navigation. This fact, together with the condition of the Dominion's finances, will probably be sufficient to dispose of any claims to governmental favor which this company may make.

A somewhat interesting decision of the Massachusetts Supreme Court arises from the distribution of the $200,000 deposited by the old Cape Cod Canal Co., organized in 1883. The charter of the company required the deposit of this sum with the State Treasurer, as security for the faithful performance of work, the payment of land damages, and the payment of claims arising from "labor performed or furnished in the construction of the canal." The supreme court has been asked to determine the manner in which this deposit shall now be distributed. There was no question as to the payment for land damages and materials, but among the claims coming under the head of labor performed were those of the president and secretary of the company and the chief engineer and his assistants for salaries for services rendered. These latter claims the court has denied; ruling that the official services of these persons were not labor under the meaning of the act. A correspondent deems that this decision is unjust and asks our opinion upon it.

Without the full text of the charter of 1883 at hand it is somewhat difficult to answer the query in all its detail. But while the ruling bears hardly upon the officers referred to, and under ordinary circumstances their labor would be quite as essential to the commercial success of any enterprise as the muscular toil of a day laborer, we believe the ruling to be correct in this case, as a fair interpretation of the true intent of the act. The deposit was demanded as security for the faithful performance of certain obligations named in the act; these were the building of a canal according to certain plans, the payment for land required and the payment for materials and labor expended in the construction of the canal. It was intended to protect certain classes, otherwise unprotected, against loss arising from the conduct of the work; but did not apply to the payment of all debts. The officers of the company were in a position to protect themselves, and the ruling of the court presumes this and limits "labor" to the specific definition of "physical exertion for the sake of gain or reward." The act itself, in other words, was specifically framed to guard the interests of those who furnished land, material or manual labor for the purposes of construction. The officers and managers of the company are supposed to be intelligent enough to protect their own interests. They could satisfy themselves as to the responsibility and solvency of the company, and if they ran risks, they did so with their eyes open.

The project to run the Brooklyn elevated and surface cars across the Brooklyn Bridge is making satisfactory progress, and encountering less opposition than usually falls to the lot of proposed public improvements. Mr. C. C. Henriques of the Board of Trustees has come out against the use of the vehicle roadway by the surface cars, although assenting to the advantages of the elevated train service on the cable car tracks. The ground of his opposition, however, appears to be rather sentimental than otherwise; his only substantial objection being that light vehicles would find it more difficult to dodge between cars to pass trucks than now. As a matter of fact the total traffic on the bridge roadways is comparatively small. The maximum on a busy day is some 2,000 vehicles in one direction. Now, if the surface cars are permitted to run across the bridge roadways, they can land 200,000 passengers in New York per day when the traffic requires. Is it worth while to oblige a hundred passengers to go to the trouble of changing cars for the sake of some fancied added convenience to a single vehicle in using the roadways.

The remainder of the trustees appear to be well satisfied of the public advantage of the proposed improvement, and in favor of carrying it out as soon as fair terms can be arranged with the railway companies, and these terms are now under consideration.

In studying the plans for handling the terminal traffic at New York, which accompanied the Board of Experts' report, and were published in our issue of Feb. 18, it appears to us that some better provision will need to be made for handling outgoing elevated train passengers at the New York end of the bridge. According to the present plans, all outgoing passengers for either the elevated or the bridge cars will leave from a single platform 20 ft. in width. The elevated trains will leave from one side of this and the bridge trains from the other. Suppose the trains are dispatched at intervals of 45 seconds, the shortest now proposed, and that the bridge trains and elevated trains are alternated. Then the interval between two successive elevated trains will be 1½ minutes. But it will be very desirable, to avoid changes of cars at other points on the route, that the elevated trains be dispatched in succession for each of three or four or perhaps half a dozen routes. Suppose that the trains for only three different routes are thus distributed, the actual interval between two successive Myrtle avenue trains, for example, would be 4½ minutes. This means that the passenger will have on the average a wait of 2¼ minutes before his particular train comes along. This would be of no importance with traffic of ordinary magnitude; but with Brooklyn Bridge traffic in the rush hours it means that as each elevated train would take away on the average only one-third of the passengers waiting, the platforms would be constantly packed to a dangerous extent, if, indeed, it were possible to operate at all. What is needed, of course, is merely a wider platform; but there is no room to put it in. A good suggestion for solving the difficulty appears to be to extend the elevated tracks around into Center St., and make the terminus for elevated train passengers there. This is an especially probable solution in case the proposed connection between the West Side lines of the Manhattan elevated system and the bridge tracks should be made through Canal and Center Sts. It is evident, however, that the problem will have to be met in some manner before the proposed through train service can be safely put into operation.

LIMITATIONS OF THE EFFICIENCY OF STEAM BOILERS.

In making tests of the economy and capacity of steam boilers the efficiency of the boiler is one of the quantities which is generally given under the head of final results. The efficiency of a boiler in a given test is simply this: If all the fuel used in the test were perfectly burned in the furnace, it would generate a certain definite quantity of heat. The percentage of this heat which the boiler actually utilizes in heating and evaporating water is its efficiency.

Now the ordinary man—and this may include some members of the engineering profession—when he sees the efficiency of any machine given as so many per cent., very naturally considers that 100 per cent. represents perfection and that a machine which is as near perfect as practice allows should have an efficiency of about 90%, or 95%, or 97%, for example. But the fact is that under our present systems of boiler construction and use any such percentages are unattainable. Under ordinary circumstances 80% rather than 100% represents approximately perfect utiliza-

FIG. 1. DEEP TRENCH FOR INTERCEPTING SEWER.

FIG. 2. GATE IN AQUEDUCT FOR FLUSHING THE INTERCEPTING SEWER.

FIG. 3. VIEW OF CHANNEL AT END OF INTERCEPTING SEWER.

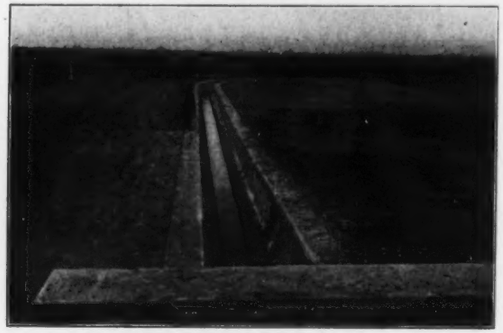


FIG. 4. VIEW OF SEWAGE FARM FROM END OF SEWER.

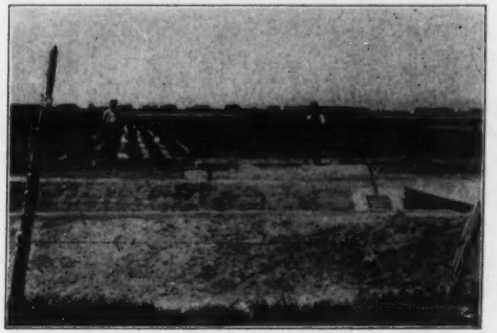


FIG. 7. VIEW OF SEWAGE FARM SHOWING MAIN AND DISTRIBUTING DITCHES AND IRRIGATING FURROWS.

INTERCEPTING SEWER AND SEWAGE FARM AT SALT LAKE CITY, UTAH.

Frank C. Kelsey, City Engineer.

tion by the boiler of all the heat that is available for utilization.

This fact is probably understood more generally now than it was 25 years ago, but it is still so commonly misunderstood, as recent evidence has shown us, that a brief discussion of the subject may be useful.

Some fifteen or twenty years ago it was not uncommon to find in the advertising columns of trade journals, and in circulars published by boiler manufacturers, statements to the effect that a test of a boiler had given a result of 13, 14 or 15 lbs. of water evaporated from and at 212° per lb. of combustible. In recent years, however, boiler testing has become more common, and it has become generally known among engineers that any figure for evaporation above, say 12¼ lbs., with anthracite coal, or over 13¼ lbs. with the best semi-bituminous coal is a practical impossibility under the ordinary conditions of natural draft. The publication of these large figures has, therefore, become less frequent. Occasionally, however, these exaggerated claims for high test records still get into print. A recent instance is found in the advertising columns of "Power," of Feb., 1897. The "Tonkin" water-tube boiler is there said to be "the most efficient and economical boiler made—eight tests showed from 11.935 to 14.668 lbs. of water evaporated per lb. of combustible from and at 212°." This boiler is a new claimant for public favor, and probably its manufacturers have as yet had little experience in boiler tests. They have no doubt published the figure 14.668 in ignorance of the fact that such a figure, if obtained in a test, simply proves that a mistake was made in the record, or that the boiler leaked or primed, or some other event took place which caused the result to be in error.

Another case in point is the publication by the Cahall Sales Department of the report of a test of a Cahall boiler by Mr. Thomas Pray, Jr., of Boston, in which the result is given as 13.968 lbs. of water from and at 212° per lb. combustible. The selling agents of this boiler not being themselves boiler testing experts may not have known that this figure cannot possibly be correct, and may have felt themselves justified in publishing any figure they should obtain from a testing expert so widely known as Mr. Pray. For Mr. Pray himself, however, it is difficult to see what excuse can be made. He has surely had enough experience in boiler testing to know that if he obtained the figure 13.968 as the result of a test some mistake or error must have occurred, and he should have so reported to his clients. What appears to be his full report of the test, however, is printed in the Cahall catalogue, and in it we find nothing which goes to show that he considered the result at all doubtful.

The Cahall Sales Department fortunately relieve themselves of the imputation of using this figure to make the public believe that it represents an ordinary performance of the boiler on a test for economy by placing alongside of it the results of four other "economy tests" of the same identical boiler by as many different experts. Their results compare with those of Mr. Pray as below:

Test No.	1.	2.	5.	7.	8.
Tested by	R.W.Hunt Co.	Armstrong Cork Co.	J. F. Swan.	Thos.Pray,Jr.	J. M. Whitham,
Kind of coal	Nut, N. Y. & C. Gas.	Nut & Slack, Summer Hill.	Run of Mine, N. Y. & C. Gas.	Slack, Summer Hill.	Sandy Creek, N.Y. & C. Gas.
Per cent. of ash	7.6	5.33	7.6	18.18	10.4
B. T. U., per lb.	13,100.	12,420.	13,100.	12,854.	....
Water evap. from and at 212°, per lb. coal	10.553	10.54	10.707	11.429	10.58
Per lb. combustible	11.430	11.14	11.987	13.968	11.81
Efficiency	77.7	81.97	79.01	85.862	....
HP. developed, % of rating	141.	111.	132.	103.	113.

The average result of tests Nos. 1, 2, 5 and 8 is 11,492 lbs. of water evaporated from and at 212° per lb. combustible, as compared with 13.968, Mr. Pray's result. The difference of over 20% in these figures is itself sufficient to throw doubt upon the latter.

Another way in which the doubtful nature of the result may be shown is by comparing the stated efficiency of the boiler, 85.86%, with an estimate of the wastes of heat. The difference between 100% and 85.86%, or 14.14%, is the sum of all the wastes of heat during the test, including loss of heat in the chimney gases, radiation, loss of coal through the grates, loss due to evaporating the moisture in the coal and that due to heating it after evaporation to the temperature of the chimney gases, together with the loss of heat due to imperfect combustion. The temperature of the chimney gases is given in the report of the test at 403° F., and that of the external air 71°. Assuming that 20 lbs. of air are used per lb. of coal burned—about as small an amount as may be used without considerable loss from incomplete combustion—or, say 21 lbs. of chimney gases per lb. of coal—and that the specific heat of the gases is 0.24, we have $(403-71)\times 21\times 0.24 = 1{,}673$ heat units lost in the chimney gases. This is 13.01% of the heating value of the coal, leaving only 1.11% to cover all the other losses. As the radiation loss alone can scarcely be less than about 3%, and the losses from incomplete combustion, and from coal removed with the ashes, would together amount to at least as much more, it is evident that the figure 85.86% for the efficiency is too high to be correct.

This figure, 85.86%, however, is based upon a calorimetric determination of the heating value of the "Summer Hill" coal, which gave it as 12,854 B. T. U. There are at least two reasons for believing that this figure is entirely incorrect. The first is that in test No. 2 the same kind of coal containing much less ash had a much lower heat value. The second is that 12,854 B. T. U. for a coal containing as much as 18.18% of ash is equivalent to 15,700 B. T. U. per lb. of combustible, an extraordinary value for any coal in the vicinity of Pittsburg, where the test was made. The Summer Hill coal used in test No. 2, containing only 5.33% ash, had a heating value of 12,420 B. T. U. per lb. of coal, which is equivalent to only 13,130 B. T. U. per lb. combustible, or 2,570 B. T. U., or about 16.4% less than that of the coal of test No. 7. This value seems as much too low for coal mined near Pittsburg as the other is too high, and the difference is additional evidence of the doubt with which all reported results of the heating value of coal, as determined by a calorimeter, must be received. If we suppose that 13,130 B. T. U. per lb. of combustible is the true heating value of the combustible portion of Summer Hill coal in test No. 7 as well as in test No. 2, the heating value of the coal used in test No. 7, containing 18.18% ash would be only 10,743 B. T. U. and the efficiency instead of 85.86% would be 106.4%.

The moral of all this is, "when you publish the result of a boiler test always keep probability in view."

In marked contrast to the statements referred to above, in which erroneous ideas are given as to the evaporation which may possibly be obtained in steam boilers, are the tables of results published in the catalogues of some of the older water-tube boiler manufacturers, showing performances which may easily be obtained in practice, when conditions are favorable. Some of these catalogues contain technical information of great value to engineers. A recent example of the publication of such useful information we find in the catalogue of the Philadelphia Water-Tube Boiler, manufactured by the Philadelphia Engineering Works, in the shape of a clear explanation of the reason why any boiler must necessarily come a long way short of utilizing all the heat which is generated in its furnace. It is so pertinent in connection with what we have said above that we reprint it as follows:

Some facts relating to combustion.—To attain the highest efficiency from the combustion of fuel, complete combustion should be effected without an excess of air.

Carbon may be burned to carbonic oxide, CO, or carbonic acid CO_2, and the carbon of the hydrocarbons may be burned or pass away as smoke.

The total heat of combustion in oxygen from each pound of

	B. T. U.	
Carbon to CO is	4400	requiring 6 lbs. of air.
Carbon to CO_2 is	14500	requiring 12 lbs. of air.
Hydrogen to H_2O (water) is	62500	requiring 36 lbs. of air.

In practice a large excess of air over the largest quantities given is required to effect approximately complete combustion, though this results in an increased loss by heat carried away in the chimney gases.

If these gases are taken at temperatures of 450° and 400° F., and the atmosphere at 60°, the available heat of the complete combustion (C to CO_2) of one pound of pure carbon is as follows:

Excess of air.	Chimney Gases 450° B. T. U.	Chimney Gases 400° B. T. U.
None	13330 or 91.9%	13484 or 93.0%
25%	13060 or 90.0%	13250 or 91.4%
50%	12790 or 88.2%	13015 or 90.0%
75%	12520 or 86.3%	12780 or 88.0%
100%	12250 or 84.5%	12545 or 86.5%
	1.85% decrease for each 25% increase of air.	1.625% for each 25% increase of air.

If 1% of the carbon is burned to CO and 99% to CO_2, the total heat of combustion will be	B. T. U. 14399 or 99.3%
If 5% to CO and 95% to CO_2	13905 or 96.5%
If 10% to CO and 90% to CO_2	13050 or 93.0%
If 15% to CO and 85% to CO_2	12086 or 80.6%

Or, 0.7% decrease for each additional per cent. of the carbon to CO.

If any of these latter percentages be multiplied by any of the former, the product will be approximately the per cent. of available heat for the two conditions. Thus, with 90% of the C burned to CO_2 and 10% to CO, with 50% excess of air, chimney gases at 450°, the available heat would be $88.2\times 93 = 82\%$ of the total heat of combustion. Showing a loss of 18%. To obtain the efficiency of the boilers this loss must be augmented by the heat radiated and conducted from the battery, and that carried away by air currents; an amount varying with the size and character of the setting and how well it is housed. In good plants this loss may be 4% to 6% of the total heat generated, or, in the example given, the boiler efficiency would be about 78%.

As the fuel increases in volatile ingredients a larger excess of air is required, and in furnaces situated under the boiler or surrounded by it not more than 65% or 70% efficiency can be had. If, with a larger percentage of combustible volatile matter, there exists in the coal an appreciable per cent. of water, there will not be in the steam more than 50% to 55% of the total heat of the fuel. The loss in the first instance is due to the dilution of the gases and the amount of C imperfectly burned, though had 100% air excess been assumed to be used, the assumption of a loss by imperfect combustion would have to be omitted. To this loss in the second case must be added much of the hydrocarbon passing away unburned, and in the third instance a still greater per cent., if not all, of the hydrocarbons with the heat necessary to volatilize them and to heat them to the temperature of the escaping gases.

LETTERS TO THE EDITOR.

The San Diego Rainfall and the Noachian Deluge.

Sir: Your correspondent, in your issue of Feb. 25, likens the heavy spurt of rain at San Diego, Cal., on Dec. 28, 1896, to Noah's flood; but that famous rainfall could only have lasted 36 hours at the longest at the San Diego rate, as the entire atmosphere, vapor, gases and all, only equal in weight a trifle over 33 ft. of water, and the whole business would have come down in a day and a half. Clearly, as two and two do not, and never did, make five, the popular reading of the result of the deluge needs revision. Truly yours, L. W. Densmore.

Hillsboro Center, N. H., March 8, 1897.

Another Heavy Rainfall in a Dry Climate.

Sir: Recent notes upon rainfall in Engineering News call to mind the excessive precipitation in this city last July. The records of the U. S. Signal Service office at this station show that in a period of three hours and five minutes, from 4.24 to 7.29 p. m., July 15, 1896, there was a rainfall of 4.70 ins., being the greatest precipitation for that length of time in the history of the office. The greater portion fell in 2½ hours. This is in the arid region where the normal annual rainfall for the station is 12.58 ins. It may be stated that storms from three directions united over the city. Respectfully,

H. B. Patten, M. Am. Soc. C. E.,
City Engineer.

Cheyenne, Wyo., March 12, 1897.

Stresses in Railway Bridges on Curves.

Sir: I notice a contribution from Mr. Henry Szlapka in Engineering News of March 4, entitled "A New Formula for So Locating Two Plate Girders Relative to a Curve as to Bring Equal Loads to Each." Mr. Szlapka has discussed only the very simple case of a uniform static loading, in which case the effects of the centrifugal force are correctly omitted, but his formula is of correspondingly limited application. The problem of so locating the center line of the track, when it is curved, as to equalize the total stresses in the two trusses of any bridge was fully discussed by me in a paper entitled "Stresses in Railway Bridges on Curves," read by me

at the annual convention of the American Society of Civil Engineers, in 1891, and published in the "Transactions," November, 1891. Yours very truly,

Ward Baldwin.

University of Cincinnati, Cincinnati, O., March 8, 1897.

Checking Multiplication by Excess of Nines.

Sir: Although perfectly aware of the possibilities of making the mistake in this process mentioned by Messrs. Hering, Scripture and others in your issue of Feb. 25, I think the probabilities are so small that they may be neglected. It seems to me that it is extremely unlikely that one would make two mistakes in the same multiplication which balance each other. Or that he would make a mistake as large as 9, or transpose his figures, as 910 for 901. In support of this theory I will say that in ten years use I do not remember a single instance where I have made such mistakes. In conclusion, I would like to say that I have found it exceedingly useful.

Yours respectfully, A. M. Steger.

Richmond, Va., March 8, 1897.

Public Land Surveys in Indian Territory Made by U. S. Geological Survey.

Sir: In your issue of Feb. 18 are two articles on the contract system as applied to the survey of public lands. It may be of interest to some of your readers to know that the government has abandoned that system in its survey of the Indian Territory. That work is being done under the direction of the U. S. Geological Survey, and is in charge of Mr. C. H. Fitch, with headquarters at South McAlester, I. T.

In the field at present are several township and subdivision parties, and attached to the latter are level and topographical parties. Each camp is in charge of a regular topographer of the U. S. G. Survey. A subdivision camp has two transit men, with six men each, a field assistant with his rodman, two teamsters and a cook. Six miles per day is a fair average of the progress for a transitman, or a township each week for one camp, including a day for moving camp. It is needless to say that the character of the work is far superior to that obtained by the contract system, the cost at the same time being less per mile of line run.

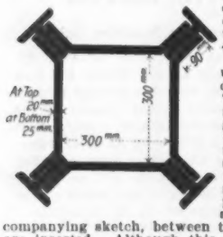
Respectfully, Wm. D. Rhea.

Nashville, Tenn., March 4, 1897.

Concerning the Goddard-Cox Box Column.

Sir: Apropos of the "new Box Column," which "is the invention of Mr. W. B. Goddard, Jr., and Mr. E. O. Cox, of Philadelphia, Pa.," as described in your last issue, allow me to submit the following translation of an extract from "Die Ingenieur-Bauwerke der Schweiz, by O. Riese, Berlin, 1887:"

The Guggenloch viaduct at Lutisburg (Switzerland), designed by Gubser and built by him in the year 1869-70, crosses the valley at a height of about 54 m. and consists of a center span of 57.33 m. with two side spans of 47.235 m. each. * * *



The most noticeable features in the viaduct are undoubtedly the iron towers. Their height, from top of masonry to under side of girder is 30.3 m. Each tower consists of four columns, whose inner hollow space measures 300 mm. square. Each column is made in a very peculiar and practical manner out of four shapes, as shown in the accompanying sketch, between the flanges of which T-irons are inserted. Although this section has the one disadvantage of requiring special rolls, it has on the other hand the very great advantage of very easy and convenient connections for the horizontal and vertical bracing and gives to the tower a pleasing appearance due to the effects of light and shade on the projecting flanges. * * *

The weight of the towers is considerably less than that of all previously built towers of similar heights, and would have been smaller yet, had the allowed unit strains been taken at a higher figure (see paper by Gubser to the Association of Engineers and Architects of Zurich, March 28, 1877. Eisenb. 1887. Bd. VI., page 119).

Yours truly, Henry Szlapka.

Trenton, N. J., Feb. 22, 1897.

(Mr. F. H. Kindl, C. E., of Pittsburg, Pa., also writes that this same column has been in use in Germany for some years. He refers to the Handbook of the Burbacher Huette, of Saarbruecken, Germany, edition of 1883, as showing various sections of the design proposed by Messrs. Goddard and Cox, as then rolled by the German firm. —Ed.)

Sir: Engineering News of Feb. 18 contains a description of a square flanged column, said to have been invented by Messrs. Goddard and Cox, and made of segments of an entirely new shape. I take the liberty to send you enclosed herewith a copy of the "Hand Book of Useful Information for Architects and Engineers," published by the Phoenix Iron Co. in 1874, on p. 115 of which, in Fig. 4, is shown the exact type of column described in the article referred to.

It appears there among other illustrations of the style of column covered by the Phoenix Column patents, and seems to prove that the invention of Messrs. Goddard & Cox is not a new one. The column with the flat segments has never been made because the circular shape of the ordinary Phoenix column gives greater strength with the same sectional area of metal, and the extra cost of curving attachment brackets to fit the circular barrel was found to be so slight as not to materially affect the question of preference.

The circular form of the Phoenix column obviously gives not only the nearest possible approach to the "constant radius of gyration," as claimed for the "new" column, but the very greatest possible radius of gyration with any given sectional area. Besides this the round flanged columns are so shapely that architects frequently use them uncased where protection against fire is not sought and decorative effect is valued.

Respectively yours, H. H. Quimby,

Chief Engineer The Phoenix Iron Works.

Phoenixville, Pa., Feb. 25, 1897.

The Study of Alternating Currents by Electrical Engineering.

Sir: Your review of Jacksons' "Alternating Currents and Alternating Current Machinery," leaves the impression that the subject of the book is one that can be satisfactorily omitted from the undergraduate work of a college course in electrical engineering. As only a small proportion of engineering students enjoy the privilege of a post-graduate year, it would appear as your belief that the average electrical engineering student must be content to get along without any training in the enormously important subject of alternating currents. I may be taking your reviewer's statement too literally, but a correction of the impression seems desirable, as instruction in alternating currents and their applications is generally conceded to be as essential in the undergraduate electrical engineering course as is thermodynamics and its applications, for instance, in the mechanical engineering course, or theory of structures in the civil engineering course. College instruction in alternating currents has been seriously handicapped until lately by the meagreness of knowledge relating to the phenomena of the subject, and by the lack of adaptable text-books. This handicap is being, or has been, removed in large part; and it is out of the question (according to the general opinion) to omit the study of alternating currents from the undergraduate course, provided an attempt is made to present as satisfactory a course in electrical engineering as is usually presented in the other great branches of engineering. There are now two or three reasonably good text-books on alternating currents from which to make a selection, and at least one of the books has been found by experience in a number of colleges to be entirely intelligible to senior students of reasonably good training.

Respectfully yours, D. C. Jackson.

Madison, Wis., March 9, 1897.

(We did not intend to leave the impression that the study of alternating currents should be omitted from a course in electrical engineering; but the tone of our review may have reflected somewhat a strong mental impression on the part of the reviewer that there is too much mathematical work in its presentation to engineering students. We freely acknowledge that the Messrs. Jacksons' work is less deserving of criticism in this particular than some other current works; but we believe there is still room for improvement. It is true that mathematics is an aid to reasoning, and a valuable labor-saving tool; but the trouble is that students, and even those who are past the student age, who become more or less adept in the use of this tool, are apt to carry on their logical processes so fast that serious errors slip in. Students ought to understand the phenomena of alternating currents by all means; but does the ability to apply a multitude of complicated equations to these phenomena necessarily tend toward their understanding?—Ed.)

The Nicaragua Canal Again.

Sir: For more than 15 years I have been what might be called a constant student of Engineering News, and have until lately looked upon the editorial writings of that paper as the opinions of its editors, given without fear or favor, and which could be relied on as sound. In the matter of the Nicaragua canal, something seems to have gone wrong, or else the present editors see fit to reverse the stand of the paper on that subject. Why this change?

It may be proper and right for the general newspapers to take their cue on this subject from the report of the late Board of Engineers on the canal; that Engineering News should do so is a very different matter. You have not only been familiar with the enterprise from its conception, but two of your editors have had an active part in it. The late A. M. Wellington was a member of a Board of Experts who spent months in the study of the maps, plans, notes, and all the data available (even the diamond drill borings), when all fresh and additional data could have been secured for the asking, the field parties being then in the field. Yet they did not see the necessity for nor require additional data to make a report that not only approved the projects and plans, but went further. Again, Mr. D. McN. Stauffer spent more time in the field, when the field parties were there, under better circumstances for gaining information than did the late Board. He had access to all possible data, and he editorially expressed an opinion as favorable to the project as even the most persistent promoter could desire. He stated editorially that the unit prices were ample, and the most prominent contractors stood ready to take the work at these prices! One of these contractors, I do not doubt, was Mr. C. P. Treat, who did not spend hours studying them from a report, but months in the field on every part of the work; another of these was Mr. A. B. Bowers, who looked after the dredging part of the work; another was the Superintendent of the Slaven Dredging Co. These gentlemen were competent to pass on the unit prices that were satisfactory, both to the then board of experts and to the editor of Engineering News; yet one great difference between the Company's estimate and the late board is these unit prices.

It can also be said that the editorial opinion of Engineering News sold stock and bonds for the Company. One of the most important structures on the canal is the San Carlos dam, and this structure, which the late board condemns the company's plan of building, was suggested by Engineering News, and adopted by the company's engineers as the very best and safest plan for this structure. Even to-day, after the board's report, they (the engineers) are still of the same opinion; but not one word has Engineering News seen fit to say in defense of this or any previous opinions expressed editorially. It cannot be said that the late board of engineers had much more or less data and information at their disposal than did Messrs. Wellington, Harvey and Hitchcock. It cannot be said that these gentlemen would or did give unqualified endorsement to doubtful or imperfect plans and projects. I do not think that the News can doubt their ability; yet their report (from the very same data, only fresher) was the reverse of the late board, if it is taken that the late board can determine nothing without additional data, that they wish two years to gather. Now, most of this is in the nature of hydraulic data of the San Juan, and Lake Nicaragua. With the ever-varying rainfall of that country, I do not think twenty years will give it in such ideal shape as the board seem to think necessary. If it could be had at a reasonable cost of time and money, well and good.

The plans and surveys for that canal are as complete, and I believe more complete, than the plans and surveys of many works started and completed by the government here in the United States. Every iota of needed additional data, to carry out that work, can and should be gained while it is in progress; and even if the additional surveys are made before commencing the work, there is not a doubt that the plans will be constantly altered as circumstances require, and that they will require it.

Gentlemen, the fight being made against the canal is not based on any doubt as to its cost or feasibility or upon the late board's report, but upon a desire, as I have seen it expressed editorially, to leave the company out in the cold, and deal directly with the greater republic of Central America. We all know that the minister from that republic has intimated his willingness to renegotiate a Frelinghuysen treaty (with its $4,000,000 to that government) for a canal that can not be built without using Costa Rica territory; and it has been hinted that the new administration would make such a treaty. Where, then, is the three years for additional surveys? Where is the doubt as to the feasibility of the canal as expressed in the board's report? To me it seems that from your connection with this matter, simple justice requires the upholding of the company's claims, and not its condemnation, for you are not to be classed with the ordinary newspaper who have no personal knowledge of what they are talking about, who get it from this or that other person. They (the papers) are not working for additional surveys, but rather against what they regard as another Central Pacific railroad deal.

It is true that you have published long extracts of the report of the late board of engineers, and also the reply thereto by the chief engineer in the same way, but THERE IS JUST ONE THING YOU DID NOT DO, therein is the milk of the cocoanut; to-wit: PUBLISH THE ITEMIZED ESTIMATES OF THE BOARDS, AND THE COMPANY. If you will do this, and analyze and comment on them, every friend of the canal will thank you.

Your editorials of six years ago are not only of interest now, but they form part of the government reports on this subject. They were and are worthy of respect, and confidence, being an unbiased opinion of able and capable engineers, given at a time when every item of data was fresh and at hand. They were not the hastily expressed opinion of an editor after an evening study; they bear the seal of the only real engineering paper of this country. It is due to those engineers that not only made the

location, but the estimates, based upon prescribed sections, and certain unit prices, due to a board of experts, one of whom is dead, who passed on these estimates, sections and plans that you publish that data, analyze and comment on it, for in this is the real difference or difficulty.

Engineers, as well as doctors and lawyers, may and do differ in opinion as to the best plan for a given structure or work, but when it comes to facts (and materials to be moved are facts) there cannot be such vast differences as we see in these estimates unless some one has blundered and badly blundered. We can withstand and meet the flood of figures given to prove that the slope of the rectified San Juan should be NIL; we can take the low water of Mr. Climie and drink it, if the San Juan ever got so low; but as man never saw it, we will not be required to do so. We might also turn, if necessary, the San Juan to build a rock-filled dam; we might be able to show that the ideal plans of ex-canal engineers exist only in the air, and are not part of any feasible location on the face of the earth; we might hunt for other causes for their proposed plans than the good of the canal "and had them." We might rest easily under this load; but the implied idea that the surveys and plans are unreliable, that our estimates are untruthful, is a load that makes us restless.

The late board stated that we placed too much dependence on the development of the topography. We are thankful for that, in so much that it is this very topography that proves beyond doubt that the canal now occupies the only possible location. I can hardly hope that you can or will publish this entire, although for 15 years I have not asked for a publication of a letter, but I do hope you will read it and devote an editorial to a review of the reports of both boards of experts and the analysis of the estimates and unit prices of these estimates. Very truly yours, J. G. Holcombe.

Tillamook, Oregon, March 4, 1897.

(To answer the last end of our correspondent's letter first, he will see by the above that we have published his letter in full, notwithstanding his doubts on that point. He says in large capitals that there is just one thing we did not do, viz., publish the itemized estimate of the Boards and of the company. If he will turn to our issue of Sept. 14, 1889, he will find the company's estimates, in as great detail as they were then available. In our issue of June 27, 1891, these were repeated in more detail. The quantities and unit prices given by Messrs. Ludlow, Endicott and Noble in their report were given in full in our issue of March 26, 1896, and the criticism of Mr. Menocal on these estimates was given in our issue of April 30. We presented fairly both sides of this question in which our correspondent says is the "milk of the cocoanut," and left our readers to make their own comparisons and form their own conclusions.

We will not take space to answer in detail all the points that our correspondent raises; but it appears to us that he misunderstands both the attitude of the Engineering Commission of 1895 toward the canal and the present position of Engineering News. Going back a little it will be remembered that the company's estimate of the cost of the canal was $65,000,000. The Wellington-Harvey-Hitchcock board of engineers, to which our correspondent refers, raised this estimate to $88,000,000 or $100,000,000, including the interest on the capital during construction. The Ludlow, Endicott and Noble board of engineers six years later was appointed to advise the United States whether it could safely invest $100,000,000 in the enterprise. Its report did not condemn the enterprise by any means; it said in substance that with the time, funds and data at their disposal they could not take the responsibility of advising the investment of this enormous sum and advised that additional data should be secured by the United States. Their provisional estimate of the cost of the canal was $133,000,000, which they explicitly stated might be proved too great or too small by farther investigation.

Our correspondent apparently thinks that it was our bounden duty to have immediately "jumped on this report with both feet," but we recognize no such obligation. Engineers, like lawyers, will disagree, as our correspondent says, and unit prices are necessarily a matter of judgment.

Our comment on the Board's report and on Mr. Menocal's reply to it was to urge the speedy prosecution of the surveys which the Board recommended. Had this been done at once, they would now be within six months of completion. The reason why the Nicaragua Canal Co. promoters fought the proposition for further surveys is probably that revealed by our correspondent in his letter. The company's concession was on the point of lapsing, and they feared that if the United States took up the works at a later date they would be left "out in the cold," as our correspondent says. As we have repeatedly shown, this attempt to ignore the report of the Ludlow Board was a huge blunder; even from the point of self-interest, we believe the chances of those who have bought canal bonds or stock getting some return from the Government would be far better if they had not blocked the proposal for additional surveys, in their desire to get back their money.

As for the editorial opinions of Engineering News, we can assure our correspondent that he is right in his belief that they are given without fear or favor. As for their soundness, that will probably be decided by each reader for himself, according as they harmonize with their own ideas. As for their consistency, it must be remembered that circumstances change with the course of years, and mistakes are made by the wisest. It is better to acknowledge an error or to change an erroneous opinion than to cling to either for the sake of mere consistency.—Ed.)

Notes and Queries.

B. J. A., Chicago, Ill., writes: "Can any of your readers tell me how to rectify warped triangles, curves, etc., of celluloid?"

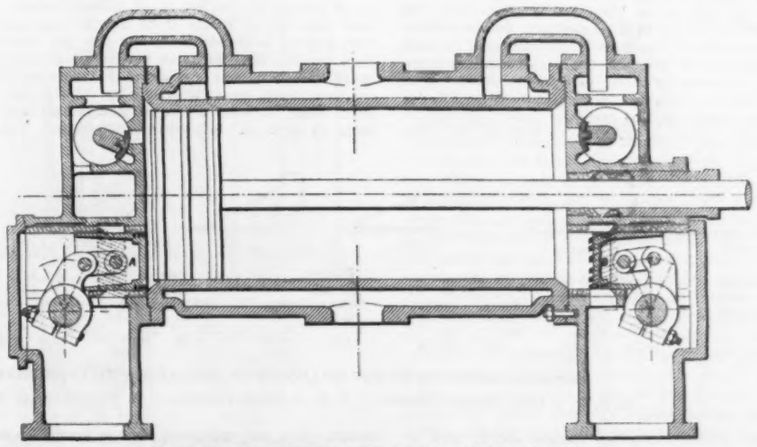
W. M. P. desires information concerning the De Laval process of electric smelting.

H. N. S. sends us an item which has been widely circulated in the newspapers to the effect that some time ago Locomotive 870 of the New York Central & Hudson River R. R. was taken apart in the shops at West Albany "and every part from the massive driving wheels to the very smallest bolt and nut were separately weighed." The very small parts were "taken to a Watervliet Avenue pharmacy where they were weighed on the pharmacist's scales." After the locomotive had been assembled again it was put into service, and after running a certain number of months it was again taken to the shops, dissected, and each part separately weighed. "Then," triumphantly concludes the newspaper paragrapher, "Master Mechanic Buchanan knew just how much the engine had lost in weight through the wear of a known amount of work."

We fail to see what information of any earthly use would be obtained by the elaborate process above set forth. If the wear of any given part of a machine is desired, there are very simple methods in common use for determining it. We do not know whether there is any foundation for the story; but in our opinion the probability is that it was made up out of whole cloth by some reporter with a fertile imagination and a sterile conscience.

A NOVEL FORM OF STEAM ENGINE CYLINDER WITH SMALL CLEARANCE VALVES.

The accompanying cut, showing a type of engine cylinder adopted by Messrs. Bollinckx & Co., Brussels, we reproduce from "The Engineer" of Jan. 29, from which we take also the following description:



STEAM ENGINE CYLINDER WITH SMALL CLEARANCE VALVES.
Manufactured by Bollinckx & Co., Brussels.

The cylinder is made in three parts bolted together, the jacket entirely surrounds it, and the steam is admitted from above, so that it may be as far as possible freed from water, and in order to make the jacket more efficient for the removal of water condensed upon the cylinder walls. The working steam enters the cylinder heads directly from the jacket, and the interior and exterior surfaces are therefore at practically the same temperature. The admission is effected through Corliss valves, but the exhaust takes place through piston valves which move backwards and forwards axially with the piston, the face of the valve or "shutter" when closed being flush with the inner face of the cylinder cover, thus reducing the clearance to a minimum—actually not more than 1%, and at the same time keeping the surface exposed to steam as small as possible. On account of those advantages a very high rate of efficiency is obtained from these engines. The valve chest in which the exhaust valve works is made of hard cast iron, and the bore is corrected by grinding; the piston being also ground to size, there is very little wear, and what occurs is mainly restricted to the piston rings. "The Engineer" is informed by Messrs. Bollinckx that a set of valves which they have had in use for the last twelve months show no signs of wear; the wear at any time must be very small, as the course moved through by the exhaust piston is only between 1-10 and 1-15 of that passed through by the main piston.

NOTES FROM THE WORK DONE ON THE CHICAGO & NORTHWESTERN LOCOMOTIVE TESTING PLANT.*

The locomotive testing plant installed in the Chicago shops of the C. & N. W. Ry., under the direction of Mr. Robert Quayle, Superintendent of Motive Power and Machinery, consists briefly of three pairs of flangeless supporting wheels, 51 ins. in diameter, mounted on 8-in. axles, supported in pillow blocks, with 8×16-in. bearings, the axles extending through the bearings far enough to receive on each end a cast-iron flangeless chilled face brake wheel 33 ins. in diameter, enclosed in a sheet iron tank. A steel brake band encircles each brake wheel, under which cast-iron brake shoes are placed. These brake shoes are drawn against the wheel by tightening the brake band by means of a lever actuated by an air cylinder securely bolted to the pillow block frame. Water is admitted at the bottom of each brake wheel tank and overflows near the top, so that the brake wheel is always immersed in flowing water. The locomotive to be tested is placed upon the supporting wheels with one driver exactly on top of each of these wheels (only two pairs being used for four coupled engines), which are first adjusted to the wheel base of the engine by moving the pillow blocks as required on bed plates, which are securely bolted to a heavy timber foundation. The locomotive is then securely connected by means of an adjustable draw-bar to a post amply braced and secured to resist the heaviest strains that the tractive power of the locomotive can exert. Provision is made for supplying and at the same time measuring accurately the fuel and water used while the engine is working under any required speed and power. The smoke and gases from the stack are carried outside the building in which this plant is located by means of a large uptake provided for this purpose. The speed of the locomotive is controlled entirely with the brakes operating on the brake wheels mentioned above. This is done automatically by attaching an ordinary ball governor to the pipe carrying the compressed air to the brake cylinders. This governor is belted to one of the supporting axles, and is provided with a series of pulleys of graduated sizes, arranged to give any required speed from 10 up to 60 miles an hour by admitting compressed air to the brake cylinders only when the required speed is reached, thus applying the brakes and making it impossible for the engine to exceed this speed. The heat generated by the friction of the brake shoes on the wheels is carried off by the water in which these wheels are immersed, which at the same time serves to a certain extent

*Abstract of paper read before the Western Railway Club in January, 1897, by E. M. Herr, Assistant Superintendent of Motive Power, Chicago & Northwestern Ry.

as a lubricant between the brake wheel and shoes, thus keeping the friction more constant than would otherwise be possible. A Boyer speed recorder, also belted to the axle, indicates and records the speed. Bristol continuous recording gages, continuous and other revolution counters, calorimeters, indicator piping and pantograph reducing motion are provided and used as necessity or occasion requires. This plant was originally installed primarily for the purpose of breaking in engines just out of the shops, and only secondarily as a device for testing their performance and efficiency. The latter use has been found so valuable, however, that most of the work done on the plant has been experimental.

The results obtained in breaking in locomotives for road service on this plant have not been as uniformly good as could be desired. There is no difficulty in breaking in the driving box bearings themselves and the rods and pins with entire success, but owing to the uniform position in which the engine stands while running it is not possible to have the bearing surfaces on all driving wheel hubs worn down to a perfect bearing. We have found in locomotives broken in on this plant that while all eccentrics, crank pins and other rod bearings, links, rockers, and in fact all bearings, excepting driving boxes, run perfectly smooth, the latter often do not, which is probably to be attributed to heat from the hubs, as the bearings which give trouble on the road ran as cool on the plant as the others. It is on this account as well as from the fact that so much important experimental work has developed that the plant is now being used almost entirely for testing. The time required to adjust the plant for receiving an engine of different wheel base and cost of changing brake shoes (the only part of the plant requiring renewal) averages about as follows:

Changing plant when set for eight-wheel engine to another of different wheel-base, one machinist and one helper....	1½ to 1¾ hours.
Eight-wheel to ten-wheel engine, one machinist and one helper.....	2½ " 3 "
Ten-wheel to eight-wheel engine, one machinist and one helper.....	2 " 2½ "
Ten-wheel to ten-wheel of different wheel base, one machinist and one helper	2 " 2½ "
Placing engine on plant and making all connections, one machinist and one helper	1½ " 2 "
Taking engine off plant, one machinist and one helper.....	¾ " 1 "

The above includes connecting the feed water supply, the governor and Boyer speed recorder.

One set of shoes will break in from eight to ten engines, when one-third of shoes will require renewal, requiring the work of two men from four to six hours. After three or four engines are broken in the shoes require adjusting, which takes two men from 45 minutes to one hour. In testing engines the plant can be run from three to five hours daily for about two weeks before shoes must be renewed. From the above it is seen that it costs from $1.25 to $2.00 for putting an engine on the plant, adjusting and maintaining brake shoes and removing the engine afterward.

It is my purpose to give a brief account of the most important work which has been done on this testing plant since its installation, about eighteen months ago. The first work undertaken was an investigation of the effect upon the performance of C. & N. W. engine No 19, a 17 × 24-in. engine, with 16 sq. ft. of grate surface and 975 sq. ft. of heating surface, of different amounts of inside clearance in the valve. Fifteen tests were made, at speeds between 25 and 45 miles per hour, and at about 6, 7 and 9 ins. cut-off. The inside clearance varied in these tests from zero or line and line to 5-16-in. clearance. Each test was run from 2½ to 3 hours, continuously, and at rates of combustion ranging from 62 to 135 lbs. of coal per square foot of grate per hour. Incidentally four different kinds of Illinois and Indiana coal were tested. The evaporation of the Indiana coal at rates of from 62 to 65 lbs. per square foot of grate per hour, from and at 212°, varied from 8.25 to 9 lbs. water per pound of coal. Illinois coal varied from 7.5 to 8 lbs. with rates of combustion of from 68 to 90 lbs. per square foot of grate. At higher rates of combustion the efficiency of evaporation decreased quite rapidly, with a slightly inferior grade of Illinois coal being as low as 6 lbs. of water per pound of coal, when the rate of combustion was from 125 to 135 lbs. per sq. ft. of grate per hour, as shown in Fig. 1.

The coal per horse power hour varied with the power developed, being least for low horse power, about 250, and, for instance, it was greatest for powers above 450 horse power. The entire range lay between the extremes of 3.55 and 4.61 lbs. of coal per horse power per hour. The highest power developed was 477 HP. at 43 miles per hour, and 7 ins. cut-off. This was easily maintained for 2½ hours and was by no means the limit of the power of the engine. A half dozen cards were taken at speeds of about 150 revolutions, or 30 miles per hour, and a cut-off of 4⅞ ins., and showed almost no variation at this speed and cut-off in mean effective pressure with

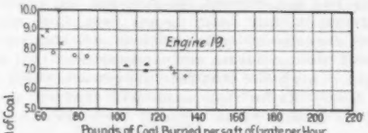


Fig. 1.

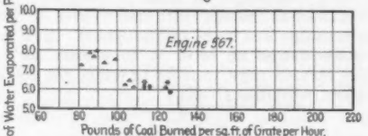


Fig. 2.

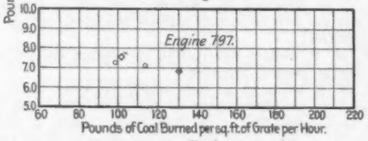


Fig. 3.

ENG. NEWS.

DIAGRAMS SHOWING COAL CONSUMPTION, EVAPORATIVE EFFICIENCY, ETC., OF LOCOMOTIVES TESTED ON CHICAGO & NORTHWESTERN RY. CO.'S TESTING MACHINE.

a gradual cutting out of the inside clearance of the valve from line and line to 5-16-in. clearance on each side. What is lost by the earlier exhaust is gained by the later compression. The efficiency of the engine in water per horse power per hour also shows very little, if any, loss, it being from 25.5 to 26.5 lbs. water per HP. per hour.

These tests were supplemented by a series of 21 others with engine No. 567, another 17 × 24-in. engine, with a slightly larger grate, 17.5 sq. ft., and the same amount of heating surface as engine No. 19, viz.: 975 sq. ft. They were undertaken with a somewhat wider range of speed, viz.: from 16 to 46 miles per hour. They confirmed the results of the former series at the higher speeds, but at the lower speeds both the economy and power of the engine decreased when the valves were given inside clearance. Fig. 2 shows the performance in this series of tests.

Still another series of four tests were made on engine No. 797, a 19 × 24-in. ten-wheel engine, with 26.9 sq. ft. of grate and 1,545 sq. ft. of heating surface. These tests were run at speeds of 16 and 35 miles per hour, with 3-32-in. inside clearance and line and line valves. Here the line and line valve showed the greatest power at 16 miles per hour and about the same at 35 miles per hour, while the efficiencies were the reverse. These tests, owing to some errors in observations, are unreliable as data on locomotive performance, but they brought out a very important point in locomotive design, not often fully appreciated. I refer to the importance of stiff and rigid eccentric rods. Engine No. 797 had long, crooked eccentric rods, such as are usually found on ten-wheel engines, and of about the ordinary stiffness. It was found, however, that these rods sprung so much, and so irregularly, as to make it almost impossible to obtain duplicate indicator cards with absolutely no change in conditions. A decided improvement has been made by making the rods of "I" section and this is now being done on all engines passing through the shops for repairs. The evaporating performance in these tests is given in Fig. 3.

As a result of these tests, checked by as careful comparative records of actual road performance as could be obtained, the following practice has been adopted on standard valves:

	Inside clearance.
For through high speed passenger service.....	⅛
For local passenger service.....	3-32
For suburban passenger freight and switching....	0

The valves of the passenger engines have also lower outside laps than those of the freight and switch service.

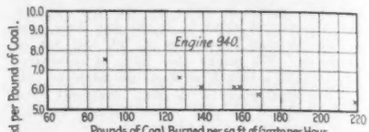


Fig. 4.

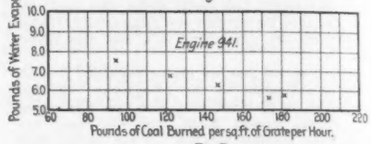


Fig. 5.

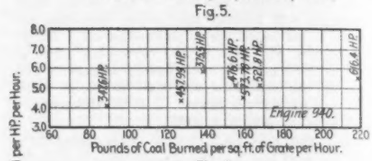


Fig. 6.

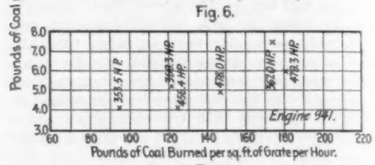


Fig. 7.

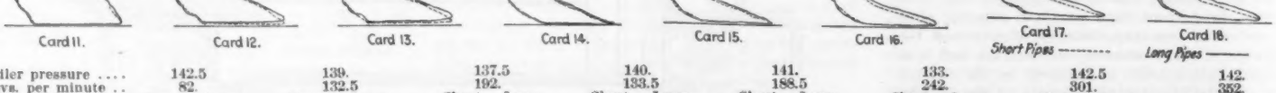
The next work undertaken was a test of the effect of a smoke burner on the boiler efficiency of engine No. 597. The tests showed that the prevention of smoke with steam jets in the firebox as arranged on this engine reduced the evaporation per pound of coal.

A feed water heater was tested on this same engine, but no advantage in economy was found by its use in several careful tests. The water per horse power hour and the evaporation per pound of coal within the errors of observation were almost absolutely identical with the results obtained with the engine run in exactly the same way before the heater was attached. This, of course, only proves that the particular heater tested was of no measurable advantage, or in other words, it did not actually heat the water appreciably. Some other design might show different results.

A special form of valve gear was next tested on an 18 × 24-in. engine No. 309. This gear had been in service until it had become somewhat worn and the test was made to determine its efficiency in this condition and to decide whether it would pay to maintain it. Its performance was so satisfactory that it was refitted and returned to service.

Next in order came the elaborate series of tests made for the American Master Mechanics' Association's committee on Exhaust Pipes, Stacks and Nozzles. The complete report of these tests has been published in the Proceedings of the Master Mechanics' Association for 1896, Vol. 29.

The effect of different amounts of lead on the economy and smoothness of operation was tested on engine No. 901, a 19 × 24-in. eight-wheel engine, carrying a steam pressure of 190 lbs. This engine has 20-in. ports and Allen valves, and it was found that improved results were obtained by reducing the lead from ¼-in. to 5-32-in. at 6-in. point of cut-off, while no worse performance



	Card 11.	Card 12.	Card 13.		Card 14.		Card 15.		Card 16.		Card 17. Short Pipes		Card 18. Long Pipes	
Boiler pressure	142.5		139.		137.5		140.		141.		133.		142.5		142.	
Revs. per minute ..	82.		132.5		192.		133.5		188.5		242.		301.		352.	
Indicator pipes	Short.	Long.	Short.	Long.	Short.	Long.	Short.	Long.	Short.	Long.	Short.	Long.	Short.	Long.	Short.	Long.
M. E. P.	95.25	95.75	68.5	68.5	64.5	63.0	48.25	49.25	44.0	47.5	39.5	45.5	39.5	45.75	38.5	45.0
I. P.	141.75	139.5	132.	128.	132.	126.	128.	126.	125.0	122.	125.5	118.	127.	120.	127.	121.
B. P.	11.50	11.50	9.5	10.75	11.0	13.75	9.75	10.5	10.0	11.	12.0	10.	15.	15.25	17.	15.5
Increase, %		0.52		0.		2.4		2.0		8.		15.2		15.8		16.9

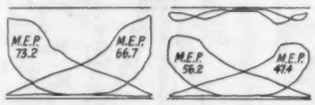
DIAGRAMS SHOWING EFFECT OF LENGTH OF INDICATOR PIPE UPON CHARACTER OF INDICATOR CARDS.

M. E. P. = Mean Effective Pressure. I. P. = Initial Pressure. B. P. = Average Back Pressure, including Compression.

as far as power is concerned was shown with ¼-in. lead at 6-in. cut-off with much smoother working. If the eccentrics are both set so as to give 5-32-in. lead at 6-in. cut off, the full gear lead with the length of eccentric rod used is nearly 3-32-in. negative. That is, the valves at full stroke are blind by this amount. Careful tests indicate that the engine is more powerful in starting with valves blind to this extent, than with a lead at full stroke up to 1-16-in. It seems probable, however, that about 1-16-in. negative lead at full stroke and 5-32-in. positive lead at 6-in. cut-off is the best adjustment of the valves for fast passenger service with the valve gear as arranged on this engine.

Even with as stiff a valve gear as was used on engine 901, and it is above the average in this respect, the effect of deficient valve lubrication is very marked. Cards No. 9 and No. 10 were taken without changing anything about the engine except the lubrication of the valves, and they are by no means unusual examples. Without changing anything about the engine except the lubrication, the horse power of the right cylinder was made to show the same as the other.

A rather complete set of 13 efficiency tests was next made on two 15 × 24-in. engines, Nos. 940 and 941, having 61-in. driving wheels, 15.7 sq. ft. of grate area, and



Card No.9. Card No.10.

Valves well lubricated.		Deficient lubrication.	
Left cylinder..6-in. cut-off.		Right cylinder..6-in. cut-off.	
Steam pressure ...	190.	.....	190.
Rev. per minute...	168.	.....	168.
Miles per hour.....	37.5	.....	37.5
Horse-power	795.	.....	589.
	589.		
Difference in HP.	206.		

Diagram Showing Effect of Deficient Lubrication Upon Indicator Cards.

1,125 sq. ft. of heating surface. These engines are exactly alike in design and construction and yet one was reported and actually showed results on the performance sheet from month to month which were much inferior to those of the other. The tests were undertaken primarily to discover the defect in the inferior engine and remedy it. The indicator cards from these engines were as nearly identical as possible, and when both engines were tested under the same conditions, their efficiency was found to be the same. The "inferior" engine, however, could with difficulty be made to steam as freely as the other on account of slightly defective front end adjustments. This was remedied, and on a test under service conditions on the road both engines did, as nearly as possible, identical work.

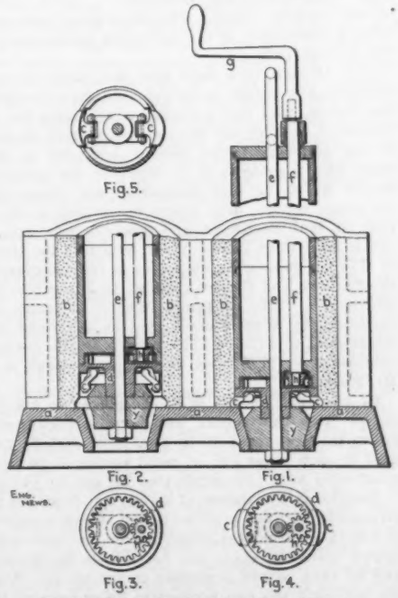
Incidentally, while these tests were in progress, the effect upon the evaporation efficiency of the boiler of varying the rate of combustion per square foot of grate was determined. In these tests no change whatever was made in the size of the grate, but the work done and consequently the water evaporated was gradually increased until rates of combustion varying from 90 lbs. of coal to 180 lbs. per sq. ft. of grate area per hour were obtained in both engines, and as high as 219 lbs. per sq. ft. of grate per hour in engine No 940. These results are shown plotted in Figs. 4 and 5. They confirm as well as could be expected under the different conditions the results obtained by Prof. W. F. M. Goss, and presented at the September, 1896, meeting of the New York Railroad Club. These curves show a rapid and fairly uniform decrease in efficiency as the rate of combustion is increased. The decrease appears to be not at as rapid a rate after that of 150 lbs. per sq. ft. of grate is reached, but to establish the correctness of this indication more data should be obtained. These tests show the results obtained from engine No. 797 in tests above referred to confirm the results obtained with the deep box for a shallow firebox boiler. The results of the boiler evaporation at different rates of combustion are shown for engines 19, 567 and 797 respectively in Figs. 1, 2 and 3. The results from both engines Nos. 19 and 567 (Figs. 1 and 2) are not as accurate and reliable as those in Figs. 3, 4 and 5, recording results obtained from engines Nos. 797 and 941. The error in the first tests was due to the water used being gaged in a tank of which the cross section was obtained by calculation. In the tests of engines Nos. 797, 940 and 941 the exact weight of water was taken. The effect upon the total economy of the engine of different rates of combustion is shown by Figs. 5 and 6, giving the coal per horse power per hour at rates of combustion covered by these tests. The horse power developed in each test is marked in figures on the diagram. Comparison of these results with those of the boiler performance only (Figs. 4 and 5) is interesting. The abnormally high points on the diagrams are due to a leaky condition of the firebox in those tests.

Analyses of the smoke-box gases while these tests were in progress resulted as follows:

Number of miles per hour.	Length of cut-off, ins.	Carbon Dioxide, per cent.	Oxygen per cent.
		Engine No. 940.	
25	4½	11.1	6.
35	4½	10.8	5.8
45	4½	10.06	8.04
25	7½	11.8	5.4
15	10	10.	7.4
		Engine No. 941.	
25	4½	9.03	9.43
35	4½	11.08	6.24
15	10	13.47	2.01

The series of tests above described on engines Nos. 940 and 941 were also utilized to give some data on the effect of long pipe connections for indicators. This subject was exceedingly well presented by Prof. Goss at the St. Louis meeting of the American Society of Mechanical Engineers in 1896, and his admirable paper on the subject is published in Volume 17 of the proceedings of that society. The errors due to long indicator pipes on locomotive cylinders were pointed out by Prof. Goss in a discussion before this club several years ago, but little interest seems to have been taken in the subject, as cards taken with comparatively long indicator pipes when taken from locomotives at high speeds are daily published as reliable. It is in fact almost impossible to take indicator cards from locomotive cylinders without the use of indicator pipes of considerable length except on a testing plant. The writer confesses that the importance of this matter for lengths of pipe no longer than ordinarily used on locomotives, say three or four feet, was not realized by him until the cards shown herewith were taken, and he wishes to expressly state that all the data based on indicator cards contained in this paper are subject to correction due to pipes 3 ft. 8 ins. long. Prof. Goss has pointed out that it is practically impossible to establish general corrections for long indicator pipes on account of the number of different conditions which modify their effect. It may be possible, however, to establish certain limits of error for known speeds and cut-offs in locomotive cylinders and for the length of indicator pipes usually used which would meet all practical requirements. It is hoped that this important work may soon be undertaken. The cards No. 11 to No. 18 inclusive were taken by the same indicator, arranged so that one card was taken through an indicator pipe 3 ft. 8 ins. long, the other being taken from a pipe about 4 ins. long. They were taken as nearly simultaneously as possible, only the time necessary to turn two cocks intervening. They show the effect of the pipe at various speeds and cut-offs, from 82 revolutions to 352 revolutions, and 6-in. and 9-in. cut-off, always to be to increase the area of the card from ½ to 16.9%.

An interesting series of tests of the tightness of cylinder packing rings was made on engine No. 567. The front steam port of one cylinder was plugged with a steam tight plug, the front cylinder head was removed and the engine was run at various speeds under full throttle with cast-iron ring packing rings made with different joints, and also with the joint in different parts of the cylinder. The leakage was carefully observed for each condition and recorded. Briefly, the results indicated that the form of the joint was immaterial as long as it was kept near the bottom of the cylinder. The rings when free tend to rotate sometimes one way, sometimes another, until they find their best bearing, then they seem to remain stationary. When rings are worn to fit cylinder and joints at or near bottom there is no leak with either lap or open joint. New rings put in cylinders only slightly worn leak until they are worn to a bearing. There was no more leakage at speed than when running slowly. The conclusions drawn from the test were that rings should not be free to turn and the joints should always be near the bottom and about 3 to 4 ins. apart.



Beading Device for Cast-Iron Pipe Patterns.
Invented by Jas. Thomson, General Manager, Gartshore-Thomson Pipe & Foundry Co., Hamilton, Ont.

Tests of the efficiencies of two two-cylinder and one four-cylinder compound engines all of different design are now in progress, but still uncompleted. Enough only is done to indicate that at the most efficient point of cut-off the compound will show considerable economy over the simple engine under similar conditions. These tests will include not only the efficiency of the engine and boiler when developing different power, but also when the cylinder ratio is varied.

One of the most valuable features of this plant is the governor, which automatically regulates the speed at which the engine to be tested runs. This regulation can be made regardless of the amount of power the engine is exerting, and so close and accurate is it that in tests of continuous running for three hours it is entirely possible to not exceed an error of 2%. This is an exceedingly valuable and really essential feature of the plant, as it enables a test run under certain conditions to be duplicated when necessary as far as speed is concerned.

DEVICE FOR FORMING THE BEAD IN MOLDS FOR CAST-IRON PIPE.

The accompanying cut shows an apparatus invented by Mr. Jas. Thomson, Vice-President and General Manager of the Gartshore-Thomson Pipe & Foundry Co., Hamilton, Ont., designed to make the pattern for the bead an integral part of the pattern in the process of molding cast-iron pipe. A further object is to form a bead that must necessarily be exactly concentric with the pipe.

Figs. 1 and 2 are longitudinal sections of a pipe-pattern with the apparatus in question attached to the foot or lower end thereof. Fig. 1 represents the pipe-pattern in position on the pouring-seat with the sand rammed about it, and Fig. 2 represents the pattern in the act of being withdrawn from the mold. a a is the pouring seat and b b the sand rammed around the pattern. Figs. 3 and 4 represent cross-sectional views of a pipe-pattern with the device in question attached. Fig. 5 is a bottom view of the device. The essential feature of the invention consists of one or more metal slicks or slickers, c c, hinged to a gear wheel d, which gearing revolves around an axis formed by the rod e running through the center of the pattern, the revolution of the gearing being produced by a rod and crank, f and g, ending in a pinion h.

When the pattern rests on the pouring-seat the slicks, from the upward pressure of the pouring-seat, take the position indicated at Fig. 1, and the outer ends of the slicks, which project beyond the line of the pattern, correspond in outline to the outline of the bead to be formed on the end of the pipe. When the pattern is in this position the sand is rammed in the ordinary way.

The gearing to which the slicks are attached is then made to revolve by turning the crank controlling the rod f, and thus the mold or matrix for the bead is formed in the sand. When the pattern is withdrawn from the mold the outer ends of the slicks fall downward and inward, as shown at Fig. 2, and thus do not disturb the mold. Fig. 3 shows the pinion at the end of the rod f, controlling the movement of the gearing d, to the underside of which the slicks are hinged.

In Fig. 3 the slicks are in the position indicated at Fig. 2.

In Fig. 4 the slicks c c are in position to form the mold for the bead as represented at Fig. 1.

Fig. 5 shows the form of the slicks and the method in which they are hinged to the gearing.

This beader has been in use in the Gartshore-Thomson Pipe & Foundry Co., Hamilton, Canada, for the last two years.

NOTES ON THE COST OF DREDGING.

Baltimore, Md.—The two forms of dredges used here are the dipper dredge for hard material and the clam-shell dredge for soft material, the latter comprising 95% of the work. Suction dredges

have not been used as the material has all been dumped into the river or into Chesapeake Bay. Land along the Patapsco River is not sufficiently valuable to justify any private enterprise in making land, and the city does not care to enter into the business, so long as safe dumping grounds can be had at less cost than the lowest bid for filling in behind a bulkhead, which so far has been 9 cts. per cu. yd., for a distance not exceeding 1,200 and averaging 600 ft. It costs about 3½ cts. per cu. yd. to dump with scows of from 300 to 500 cu. yds. capacity, and about 5 cts. with scows of from 100 to 200 cu. yds. capacity. Even the dredging by the U. S. Engineers on the ship channel, being from 1½ to 2½ miles from shore, would require the rehandling of the material to put it behind bulkheads. In 1895, Mr. N. H. Hutton, Engineer of the Harbor Board, stated that fair prices for dredging would be 12½ cts. per cu. yd. for the harbor, channels and Middle Branch, and 15 cts. per cu. yd. for the Back Basin and docks. He also sent us the following table of the amount and cost of dredging for 10 years, the variations in prices being due to variations in competition, which largely depends upon the amount of river and harbor work for the U. S. Government which is in the market. All the dredging was soft material, except at the mouth of the harbor which was tough clay and compact fine sand. The tow averages 12 miles for all dredging. In the Back Basin and docks the work was slow on account of the crowded harbor.

Dredging at Baltimore, Md.

	Harbor and channels. cu.yds. cts.	Back Basin and docks. cu.yds. cts.	Middle Branch. cu.yds. cts.	Mouth of harbor. cu.yds.cts.
1885..	286,287 11	101,251 11	40,624 10	....
1886..	195,126 11	116,253 11	128,692 11	....
1887..	173,413 11	50,175 15½	40,284 11	19,490 30
1888..	123,578 14	52,430 19	47,631 15	1,660 25
1889..	95,542 13	44,751 21	16,056 14	3,290 35
1890..	82,686 12	61,156 16	83,911 12	....
1891..	23,070 13	58,399 17	77,127 13	....
1892..	96,736 10.8	142,453 14.9	237,397 13½	55,327 22
1893..	85,908 12½	43,880 15½	53,781 13	31,217 27
		81,631 16¾		
1894..	60,529 12	60,334 15	54,591 12½	10,770 25
1895..	....	*100,000 11.9	(Tow only 2½ to 3 miles)	

*More or less.

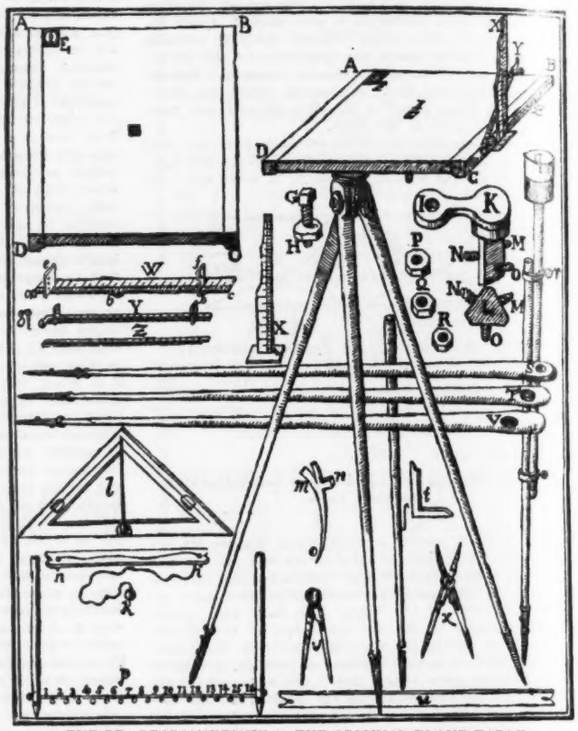
New York City.—Mr. G. S. Greene, Jr., M. Am. Soc. C. E., Engineer in Chief of the Department of Docks, has stated that the average cost of mud dredging done by this department is about 20 cts. per cu. yd.; crib-dredging, $1 per cu. yd. There has been no difference in the price whether clam-shell or dipper dredge was used. No ladder-dredges have been engaged upon the department work. These prices include the cost of disposing of the dredged material.

THE ORIGINAL PLANE TABLE AND THE INVENTION OF THE STADIA.

In a late lecture upon "Topographical Surveys, their Methods and Values," delivered before the students of the College of Mechanics and Engineering, of the University of Wisconsin, Mr. J. L. Van Ornum, Instructor in Civil Engineering at Washington University, St. Louis, sketches the history of various more or less familiar engineering instruments, and the methods employed by some of the more ancient engineers. In this connection he gives what is, we believe, the first illustrated account in an English publication of the so-called Praetorian Mensula, otherwise, the original plane-table.

The invention of the plane table is definitely credited to Johann Praetorius, a famous mathematician, who is supposed to have designed this instrument in 1590. To make plain its peculiarities and principles of construction. Prof. Carl Dziatzko, of the University of Gottingen, has translated and condensed the description of this instrument as found in the "Geometriae Practical" of M. Daniel Schwenter, published in Nuremberg in 1667.

The fac simile of the original illustration is here reproduced from the published paper of Prof. Van Ornum, in the Bulletin of the University of Wisconsin. Briefly described, this figure represents a plane board, 15 ins. square and an inch thick, mounted upon a tripod. This board carries a compass in one corner and a spirit-level (not shown but necessary); and the board is connected with the tripod-head by the piece K and the square-headed screw G H let into the center of the board at I. What is called the chief scale is shown at W, and is described as being a graduated brass scale, 14 ins. long, by one inch wide. At one end is left a semi-circular piece of brass a, and through this is a very small hole on the line of the edge of the rule through which a fine needle can be passed. Six inches from this is a similar piece b; and two sights, e and f are employed. The sight e has three fine holes, perpendicular to the edge of the scale, and in a plane with it: the sight f has a hole cut in it with a fine wire stretched across this hole in the plane of and perpendicular to the edge of the scale; and both of these sights are hinged, so that they may be turned down. Three other graduated brass rules, X, Y, Z, are called the side-rules. The rule Z, 12 ins. long, is fastened rigidly to the cleat B C; the rule Y is similar to Z, but has a piece of brass, with a hole in it, at one end, and this rule is fastened to the cleat B C by the small screw g, so that it coincides with Z. This last rule also has two sights, like the chief rule W. The third rule, X, is 9 ins. long and soldered to a square piece of brass, so that it stands on the table perpendicular to Z, and the point where the top edge of Z crosses this rule is taken as the zero of the scale. The rule n l, with the plumb-bob attached, is used for centering the table over the point in the field; and the target g, triangle l, square t, measuring rod p, rule u, and compass y complete the secondary equipment of the mensula.



THE PRAETORIAN MENSULA (THE ORIGINAL PLANE TABLE).

As compared with modern plane-tables the mensula has the tripod, compass and spirit-level much the same; but the peep-sights are now supplanted by the telescope and the side rules for determining the vertical component, are replaced by the vertical circle. The description also contains a suggestion of the centering device used at the present time.

Prof. Ornum also says that the credit of first applying the stadia is erroneously given to William Green, who was awarded a premium for his invention, in 1778, by the London Society of Arts. In the same year the Danish Academy of Sciences gave a prize to G. F. Brander, for a similar device which he had applied to his plane-table six years before. But closer investigation shows that its real discoverer and original user was no less a man than James Watt, who used the stadia in 1771 for measuring distances in the surveys for the Tarberk and Crinan Canals. In James Patrick Muirhead's "Life of James Watt," is found the statement by Watt himself that he contrived this instrument in 1770 or 1771, used it in the surveys mentioned in 1771, and in 1772 he showed it to Mr. Smeaton.

As described by Mr. Watt, he placed in his telescope two horizontal and one perpendicular hairs; the first two 1-10-in. apart and strictly parallel to each other and at right angles to the perpendicular hair. He graduated his rod by placing it upright at a distance of 20 chains; from his instrument; he fixed a white target, 8 ins. diameter and with a horizontal vermilion line, one inch wide, drawn across it, about one foot above the ground, and he then moved a similar target up and down the rod until the two horizontal hairs covered the two targets. The distance on the rod between these target-centers was divided into 20 parts, representing chains; and these divisions were 4½ ins. long each, on the rod used. Watt found that for distances exceeding 5 chains this division was accurate enough; but he had to make corrections, ascertained by sights on single chains, for distances under 5 chains. He commonly used a 12-ft. rod, but also sometimes employed a sliding rod for greater distances than 30 chains. He placed his possibility of error at less than 1 in [illegible], but also stated that with a higher magnifying power he could do more accurate work.

Mr. Watt was apprised by Mr. Smeaton of the claim of William Green, and he informed the Society of Arts of his priority of invention and was present at the meeting. Yet the Society saw fit to award the premium to Mr. Green, because he had used a higher magnifying power and had measured greater distances.

Italy was the first country to extensively employ the stadia in its surveys made in 1823; its use spread to Switzerland in 1836 and thence extended over Europe. It was brought to the United States, says Prof. Ornum, by J. R. Mayer, who came from Switzerland in 1848, and it was first extensively employed in the survey of the Great Lakes.

HARDWOOD PAVEMENTS IN SYDNEY, NEW SOUTH WALES.

Mr. R. W. Richards, A. M. Inst. C. E., City Surveyor of Sydney, New South Wales, lately read before the English Association of Municipal and County Engineers a paper on the latest experience with hardwood pavements in Sydney. An abstract of this paper follows:

The first wood pavement in Sydney was laid in 1880, and various kinds of well seasoned hardwood were tried, cut in blocks 9×6×3 ins., and laid on a 6 to 1 concrete base, 6 ins. deep, floated on the surface with cement mortar. Upon this base the blocks were laid with 1-in. joints, the joints being filled with bluestone screenings and tar. When the joints were thoroughly grouted, flush with the surface, a top dressing of clean, coarse sand and tar was spread to a thickness of ¾-in. over the entire surface, and the roadway was thrown open to traffic. The several kinds of wood were laid separately and included red gum, black butt, ash, box, Baltic blue gum, brown pine and cedar. In less than five years the ash, Baltic, brown pine and cedar began to fail, and by 1893 the whole of the original pavement had been removed and replaced by blocks of blue gum. In 1887 the width of joint was reduced to ⅝-in., and in 1888, to ¼-in. This reduction of the width of joint decreased the noise from the pavements.

which had been seriously complained of. Finally, a length of road was laid with butt joints, with the blocks dipped in tar and hammered up at every twelfth row and afterwards flushed with boiling tar and river sand. When this pavement was opened to traffic, in 1888, the noise was found to be not more than that from an asphalt pavement.

As the result of 17 years' experience, Mr. Richards came to the following conclusion: That the best pavement for heavy and continued traffic was one laid with New South Wales hardwood, on a good concrete base, with slope or butt joints and a convexity of 1 in 60, or 1 in 80, as the longitudinal gradient required. This pavement must be properly cleaned and maintained. The best wood for such a roadway was tallow-wood, black butt, blue gum, red gum and mahogony. These timbers, as laid in the streets of Sydney, show a wear of 1-60 to 1-80-in. per annum, and have required absolutely no repairs. Recent close-jointed pavements in Sydney cost 15s. 6d., or $3.72 per sq. yd. Mr. Richards says there is no trouble from expansion in using the close joint, in fact, expansion actually seems to be less than with the old wide joint. But to meet any objection on this point a 2-in. seam of sand or clay may be laid parallel with and close to the curbing. Outside of this seam are then laid planks of hardwood, 12 ft. long by 3 ins. thick and 6 ins. deep, set at the full depth of the blocks. These planks break joints on opposite sides of the street; and when these have been used the expansion has not been appreciable.

Mr. Richards has preserved specimens of blocks removed from the Sydney pavements after about 12 years' use. These show the following rates of annual wear: Red gum, 1-48 in.; grey gum, little used, 1-14 in.; spotted gum, unsatisfactory; iron bark, 1-48 in.; turpentine wood, 1-16 in.; tallow wood, 1-48 in.; blue gum, 1-48 in.; black butt, 1-96 in. All of these blocks were laid with ¾-in. joints. The authorities caused these old blocks to be removed from the earlier laid pavements, cleaned, cut down to 5 ins., and relaid with close joints, at a total cost of $0.57 per sq. yd., including cost of removal. The roadway so paved was in every respect equal to those laid with new blocks.

In the discussion which followed this paper the statement was made that the amount of traffic had much to do with the rate of wear. At the several Euston Road termini, in London, traversed by 300 busses hourly, black butt and tallow wood showed a rate of wear of 1-16 in. per year.

In answer to various questions, Mr. Richards said that in regard to the sanitary characteristics of wood pavements, the Sydney Board of Health, in 1882, especially examined the wide joints in pavements for pathogenic germs, but found none. The close-jointed pavement was as noiseless as asphalt, there being a perfectly smooth surface with the necessary amount of elasticity. The only noise noticed was that due to the axies and construction of the vehicles. He thought that while jarrah and karri were good woods for pavement, they could not compare with the black butt of New South Wales. All slipperiness was remedied by sanding, and with a view to preserving the timber, it was the practice to dip the blocks in a boiling mixture made up of 2 parts tar to 1 of pitch. As to the wear on Euston Road, which was referred to, Mr. Richards said that on a certain thoroughfare in Sydney, only 36 ft. wide, a 24-hour observation showed a rate of 330 vehicles per hour passing; and in another street the hourly traffic reached 500. As to the extremes of temperature, the thermometer sometimes indicated 104°F. in the shade, at noon, and the climatic condition were such as to sometimes reduce the temperature 22° in one hour. Under these conditions there was a certain amount of contraction in the pavement. Wages in Sydney were 8s., or $1.92 per day when the first pavements were laid and are now 6s., or $1.44 per day; and the labor in grouting the wide joints accounted for the difference in cost between $6.48, for the old wide-joint pavement per sq. yd., and the $3.72 now paid. The margin of error allowed in cutting the blocks was only 1-16-in. and only 1% were rejected. The wood paving of Sydney now covers 80 acres in area, and about 20 miles in length of streets; and the annual cost of sanding these streets is $6,000.

VENTILATION DIFFICULTIES IN THE ARLBERG TUNNEL.

The "Revue Generale des Chemins de Fer," for February, 1897, contains an article upon the Arlberg tunnel, 6.4 miles long, and the portion relating to the ventilation of this tunnel is here abstracted, as follows:

The mean annual temperature at Saint Anton, at the east end of the tunnel and situated 4,274 ft. above sea-level, is + 3.8° C., or about 39° F.; while that at Langen, 3,992 ft. above sea-level, is + 5.3° C., or about 41° F. At Saint Anton, the maximum difference between the hottest and the coldest month of the year was 74° in 1891. The temperature of the air in the tunnel increases in going in from both ends; but after entering a short distance the temperature becomes established and varies very little throughout the year; the mean annual temperature of the air in the tunnel being about 55° F. The temperature of the rock has been measured since 1883, and in that year the mean annual temperature was 65.3° F.; in 1894 it was 56.8° F., the temperature of the rock having lowered 8.5° in eleven years.

The direction of the air currents in the tunnel depends upon the barometric pressure at the extremities, the temperature and the hygrometric conditions. The force of the current depends also upon the heating of the air in the tunnel, the coefficient of friction against the sides and the number of trains. But the currents from the West predominate and represent 50% of all the currents observed. From spring to autumn, when the days and nights are about equal in duration, there is often a complete cessation of motion in the air in the tunnel, though this stoppage rarely lasts for more than 3 or 4 hours. During good weather, and when the air is quiet on the summit of the Arlberg, there is a slight daily current from the East, between 9 and 11 o'clock; but at the latter hour this is transformed into a strong current from the West. This phenomenon occurs daily whenever there is no modification in the atmospheric conditions in the interval. During eight years of observation the mean annual rainfall has been 44⅞ ins. at Saint Anton, and 64⅞ ins. at Langen, on the western slope.

The Arlberg tunnel, with the exception of a slight curve at the East entrance, is straight, and lies about East and West. The East entrance is the highest above the sea, and from this point the grade rises at the rate of 10.56 ft. per mile for 13,795 ft.; it then falls at the rate of 79.1 ft. per mile to the western entrance, the difference in the elevation of the two ends above sea-level being 282 ft. The section of the tunnel is equivalent to 442.6 sq. ft., and the volume of air contained in the tunnel is 14,889,540 cu. ft.

No artificial ventilation being originally used, that obtained was due only to natural agencies, or to the difference in level of the two ends and the difference in temperature in the air within and outside the tunnel. Very soon after the tunnel was opened to traffic the use of coal as a combustible had to be abandoned, as the tunnel was constantly filled with smoke and it was impossible to see the signals used in operating the trains. At the end of 1885 the company commenced to use coke for its locomotives, and the nuisance referred to disappeared, and for the first few years of operating there was no further trouble. But by 1888 the traffic had increased to an unexpected extent, and in every 24 hours 31 trains, drawn by 62 locomotives, passed through the tunnel, and nine of these trains passed each other in the tunnel. Even then no abnormal effects were noted until September, 1890, when a number of workmen employed in the vitiated air in the tunnel were overcome by the gases and were only saved by being quickly taken to the open air.

Several accidents of a similar kind led the administration to carefully examine into the ventilating conditions in the tunnel, and to also investigate the chemical composition of the air. It was first remarked that all these accidents to the men happened between 8 and 11 o'clock in the morning, just after the passage of seven successive trains, with two meeting in the tunnel. The result was the accumulation of a great quantity of smoke and gas, just at the hour when there was generally a change in the direction of the air-currents, as before remarked. The accidents also immediately followed a change of combustibles, from the coke of Haute-Silesie to that of Nezvistic and Littiz.

The study of the air conditions showed that during the first six years of operation when there was no trouble of any moment, the ballast in the roadbed and the masonry possessed great power of absorption of the gases resulting from combustion. Until these were completely saturated the air in the tunnel was not seriously vitiated and the renewal of the ballast was suggested as one means of improving the air conditions. It was also recognized that to diminish the pernicious influence of the gas it was necessary to use a fuel as dry as possible and to obtain complete combustion of the coke on the furnace grate.

For the first purpose a storage bin, containing 200 tons, was built at Langen and the fuel completely protected from atmospheric influence. From this bin the coke was transported in closed wagons painted with coal tar. The engine drivers were also instructed to clean their fires before entering the tunnel, and to keep up a low fire, very bright and clean upon the grate, during the passage through the tunnel. It was also decided that an interval of at least one hour must be maintained between any two trains.

Notwithstanding these precautions accidents from gas still occurred to men working in the tunnel, and some of them were serious. The administration then determined upon using some system of artificial ventilation, and concluded to try the system introduced by M.Saccardo at the Pratolino tunnel, on the Bologna-Florence railway. This system practically amounted to driving out the foul air by means of powerful fans, or ventilators; and the pipe for this purpose was to be let into the arch masonry. The system was tried over a short length of the tunnel, but was unsatisfactory, and another plan was suggested. That was to install in niches along the sides of the tunnel reservoirs of highly compressed air. This scheme promised good results, as experience had demonstrated that a very small quantity of pure air introduced into the tunnel would prevent serious trouble even when the air was most vitiated, and it would permit the men to continue at work.

But in May, 1894, a locomotive was introduced fitted with a Holden apparatus for burning petroleum, and the results were so generally favorable, both from an economical view and that of steam producing, that it was decided to use petroleum fuel in the tunnel, and by the end of 1896 all locomotives were fitted with the Holden device. A careful examination was made by Prof. Senhofer, of the University of Innsbruck, into the influence of the combustion of petroleum upon the composition of the air in the tunnel, and in his general report he favors the use of the liquid fuel, as compared with other combustibles tried.

STANDARD SPECIFICATIONS FOR METAL BRIDGES, BOSTON & MAINE R. R.

New standard specifications for metal bridges have just been issued by Mr. J. P. Snow, M. Am. Soc. C. E., Bridge Engineer, Boston & Maine R. R., which contain several requirements that differ considerably from those usually demanded. For the benefit of our readers interested in following out the new ideas adopted from time to time in bridge work we abstract here some of the more novel features of these specifications. Continuity of statement has not been attempted and indeed is impossible in selecting clauses scattered through a lengthy specification and this should be borne in mind in the reading. Rearrangement and abbreviation have been made also wherever it has been possible to condense without destroying clearness by so doing. The following are the various clauses worthy of especial notice:

(1.) Unit strains will be based upon the ratio of dead load to total load, modified as specified below. Table 1

gives these general tension units. For members subjected to one kind of strain only.

$$R = \frac{\text{dead load}}{\text{total load}},$$

and for members subjected to alternate tension and compression,

$$R = \frac{\text{maximum compression}}{\text{maximum tension.}},$$

When the compression is numerically the greater the tension unit will remain at 5,000. The compression unit shall be as specified below, and that one used which gives the larger gross section.

(2.) In the following modifications a is the tension unit from the above table, corresponding to the proper value of R. The unit strain for general compression shall not exceed,

$$\frac{a}{10{,}000} \times \frac{8{,}700}{1 + \frac{l^2}{28{,}000r^2}}$$

for riveted members and,

$$\frac{a}{10{,}000} \times \frac{8{,}700}{1 + \frac{l^2}{14{,}000r^2}}$$

for pin members, in which l is the length and r the least radius of gyration, both expressed in the same unit.

(3.) In girders the flange units shall be modified by the ratio of effective depth to length as follows: The tension unit shall be,

$$a\left(\tfrac{1}{2} + \frac{5d}{l}\right),$$

in which d is the strain depth and l the effective length of the girder, but it shall never exceed 1¼ times the value of a. The compression unit shall be,

$$\frac{\text{tension unit}}{10{,}000} \times \frac{9{,}000}{1 + \frac{l^2}{5{,}000b^2}},$$

where l is the unsupported length of the compression flange and b its width. Where the girder is riveted at both ends to the webs of other girders, the unsupported length may be taken as three-fourths the actual length of the top flange.

(4.) The shear on webs per square inch of vertical section shall not exceed,

$$\frac{a}{10{,}000} \times \frac{12{,}000}{1 + \frac{d^2}{2{,}500t^2}},$$

where d is the depth between flange angles or clear distance between uprights and t is the thickness of web.

(5.) The bearing on rivets (diameter multiplied by thickness of iron) per square inch shall be:

	Single action	Enclosed bearing.
Machine driven	a × 1.25	a × 1.5625
Hand driven	a × 0.9375	a × 1.172

(6.) The bearing on rollers per linear inch shall be, for iron, 350 × diameter; for machine steel rollers and plate, 470 × diameter; for hard steel rollers and plate, 540 × diameter.

(7.) Tension in laterals shall not exceed 10,000 lbs. per sq. in., nor,

$$10{,}000\,\frac{2d^2}{l^2},$$

where d is the distance center to center of trusses and l the length of lateral. Other strains for bracing and its connections shall corespond to a tension unit of 10,000 lbs. per sq. in.

(8.) Adjustable members shall be proportioned for an initial strain of 10,000 lbs. When the calculated external strain in adjustable diagonals is less than 20,000 lbs., the maximum strain on the member shall be taken as 10,000 plus one half the calculated strain. When the calculated strain equals or exceeds 20,000, it shall be used as the maximum and the initial strain ignored.

(9.) In the case of double track bridges, if the strains are computed for both tracks loaded with trains abreast and headed in the same direction, the unit strains in trusses and girders may be increased as follows: For bridges with two trusses or girders, 7½%; for bridges with three trusses or girders, 10%, on middle truss or girder.

(10.) The allowable bearing for rivets when a equals 10,000 shall be as given by Table II.

(11.) In the top flange of built stringers and deck plate girders, without top plate, the rivet pitch shall be not more than 4 ins. at the center of space, and this shall be reduced to 2 ins. near the ends. This is to provide rivet bearing for carrying the wheel load on the ties to the web.

(12.) When the top flange is without cover plates the web shall be at least flush with the top angles; if it projects more than ⅛ in. above the angles it must be chipped off.

(13.) The thickness of metal connected by hand-driven rivets shall not exceed 2½ times the diameter of the rivet used, but for machine driven work the ratio may be 3½ in trusses and 5 in plate girders.

(14.) Counter diagonals shall extend toward the ends of trusses to the foot of the first rigid vertical. No counter shall be used less than a 1¼ ins. square bar. The laterals in the loaded chord shall in all cases be rigid bracing.

(15.) Pin holes must be adequately reinforced and there must be a sufficient number of rivets in the plates properly to transmit to the angles the strain taken from the pin by the plate. Where flanges are cut back for clearance the pin plates shall extend beyond the cut to allow two full lines of rivets across the member. Floor beams suspended below the bottom chord by hangers free on the pins, or by any kind of screw end hanger, will not be allowed.

(16.) Shoe plates shall be so designed that the pressure will be well distributed over the masonry. Wall plates will be preferably of cast iron, and are to be well doweled to the masonry by anchor bolts, secured by sulphur or neat Portland cement. The thickness of cast iron wall plates will be at least 1-10 the largest dimension of the shoe plate resting on it.

(17.) The ties will generally be 8 ins. wide and 7 ins. high by 12 ft. long, spaced 4 ins. apart and notched to 6½ ins. over the stringers. In bridges with considerable camber and of more than one span the ties will be deeper to allow of framing out a portion of the camber, and of having a notch of at least ½ in. over the piers. Tie spacers 6 ins. deep by 8 ins. wide will be dapped 1 in., and secured at the ends of the ties with a 9 × ¾-in. lag screw in every fourth tie. In double track bridges with center stringer, the ties will butt on this stringer and be spaced by a 6 × 12 ins. dapped over them and secured by lag screws 2 ft. apart staggered. All ties and spacers will be Southern long-leaf pine of prime quality, Savannah inspection. In all bridges the main stringers will be placed 5 ft. on centers, and in single track bridges the side stringers will be 10 ft. on centers. In double track bridges having two trusses a single stringer will be placed in the middle between tracks, and side stringers 5 ft. out from center of each track. Deck plate girders over 30 ft. long will generally be 9 ft. on centers, with floor beams supporting stringers 5 ft. apart. The tops of these stringers will be level with the tops of girders and the ties will be notched over all. In all cases of skew bridges the stringers shall be extended at ends of bridges so as to finish square to the track. The parapet stone shall not be over 8 ins. wide on top; it shall be not more than 1½ ins. below the rail, and must be so placed that the end bridge tie, the first ground tie, will not be more than 24 ins. on centers.

(18.) Hand driven rivets must be made from puddled iron or basic open-hearth steel. If of iron, they must be from stock which has been rerolled from bars made wholly from muck iron; that is, it must be piled and reheated twice. It must show an ultimate strength of at least 50,000 lbs. per sq. in., an elongation not less than 20%, and a reduction of area at least 40%. Manufactured rivets must bend double, hot or cold, in close contact, without sign of fracture on the convex side and with no sign of hot or cold shortness. When nicked and bent, they must show a fine fibrous texture. If these rivets are steel, satisfactory evidence must be furnished that it will fill the following requirements: Ultimate strength not over 52,000 lbs. per sq. in., elongation at least 30%, reduction of area 60%, with phosphorus and sulphur below .03% each. Manufactured rivets must bend double in close contact perfectly, both cold, hot, and quenched from a bright orange heat, without cracking or showing any signs of hot or cold shortness; ⅝-in. rivets nicked must bend double cold with the nick on the outside without fracture.

ONE THOUSAND WATER METERS are to be put in at Richmond, Va. The meter question has been under investigation there for some time.

THE CHEMICAL ELECTRIC METERS heretofore used by the Edison Electric Illuminating Co., of New York city, are being displaced by Thomson mechanical watt-meters. It is stated that the principal reason for the change is that many of the customers of the company prefer a meter in which they can "see the wheels go round."

AN AMENDMENT TO THE PATENT LAW was passed on March 3 during the closing hours of the 54th Congress. The following are the changes in the law made by this Act:

Sec. 1. Two years' publication by patent or otherwise prior to the application is a bar to a patent.

Sec. 2. A defendant may plead such two years' publication as a defense against a patent.

Sec. 3. The application on an invention patented abroad must be filed within seven months of the earliest foreign application; the patent will then be granted for seventeen years. If the application is not filed within that time the patent, if granted, will be void.

Sec. 4. Applications for patents must be completed within one year (instead of two years, as formerly), and response must be made to any official action within one year (instead of two years).

Sec. 5. Assignments, if acknowledged before a notary or other proper officer, are self-proving.

Sec. 6. In actions for infringement there shall be no recovery of profits or damages for more than six years before commencing the action.

Sec. 7. This Act shall take effect Jan. 1st, 1898. Sections 1, 2, 3 and 4 shall not apply to any patent previously granted, nor to any application previously filed, nor to any patent granted on such an application.

THE ELECTRICAL CONDUCTIVITY OF ALUMINUM is discussed in a paper by Messrs. Joseph W. Richards and John A. Thomson in the "Journal of the Franklin Institute" for March. They tested five samples, of different degrees of purity, and obtained the following results:

Per cent. pure aluminum	99.96	99.58	98.77	97.16	94.39
Conductivity, copper = 100	64.4	61.1	55.5	56.0	57.5

The comparison is made with Sir Wm. Thomson's value for the specific resistance of copper, which is 1,580 C. G. S. units of resistance per cubic centimeter. The temperature coefficient they found to be 0.00392 per degree C. for the purest wire. According to experiments by Mr. C. F. Scott, electrician of the Westinghouse Electric Co., the temperature coefficient decreases slightly with the decrease of purity, being 0.00359 per degree C. for the wire of 94.39% Al. Comparing their own results with those of other experimenters, they arrive at the following approximate figures for the conductivity of hard-drawn commercial aluminum:

Per cent. pure aluminum	98.5	99.0	99.5	99.75	100
Conductivity, copper = 100	55.0	59.0	61.0	63-64	66-67

Annealed wire has a conductivity nearly 1% greater than unannealed. These results confirm those given in a letter from Mr. Alfred E. Hunt, President of the Pittsburg Reduction Co., in our issue of Dec. 17, 1896.

A SHORTHAND WRITING MACHINE has been invented by Mr. J. F. Hardy, of England. The London "Times" describes it as being very portable, measuring 8 by 7 ins. by 4 ins. high. It is virtually silent in operating and may be described as a miniature typewriter, with only six keys. By the various combinations of these keys, struck with either hand, a species of Morse short hand of dots and dashes is produced on a roll of ordinary thin paper. It prints in regular lines across the sheet and automatically shifts from one line to another. The inventor claims that the system is easier to learn than ordinary "pencil short hand." The machine costs "a few pounds" only.

A MOTOR-WAGON LINE between Liverpool and Manchester, a distance of 37 miles, is being discussed. It is proposed to use steam-driven motor wagons carrying about 7 tons of merchandise, with a trailer car behind carrying 6 tons more. The average speed would be about 4 miles per hour, and the steepest gradient is 1 on 18 for about one-quarter mile. Oil fuel would be used with a steam pressure of 200 lbs. The promotors think that at a charge of 2 cts. per ton-mile the scheme would be very profitable.

THE BRITISH EXPORTS OF TIN PLATE to the United States for the past four years were as follows, in tons of 2,240 lbs.: 1893, 225,628; 1894, 226,879; 1895, 222,901; 1896, 113,051, showing a falling off of 50% in two years. The American tin plate plants are now reported to be running at nearly their full capacity, producing at the rate of 4,500,000 boxes or about 200,000 tons per year.

THE RATE OF PRODUCTION OF PIG IRON being commonly considered an indication of the general condition of business throughout the country, the following figures of rate of production since Oct. 1, when it reached the lowest point for the year 1896, are of interest. They are taken from the "American Manufacturer" of Mar. 12, and represent the producing capacity in gross tons per week of the furnaces in blast at the several dates: Oct. 1, 114,410; Nov. 1, 126,956; Dec. 1, 141,410; Jan. 1, 163,576; Feb. 1, 168,687; Mar. 1, 178,900. The last figure is nearly 19% below the maximum rate of production, or 219,326 tons, which was attained Jan. 1, 1896, just after the short-lived boom in the iron trade which took place in the latter part of 1895. The increase since Oct. 1, however, in the face of many conditions unfavorable to good business is most encouraging, and gives reason for the belief that the maximum figures given above will soon be reached and passed.

COMPENSATION FOR FRANCHISES is advocated by Mayor Strong, of New York, in approving the pneumatic tube bill introduced at Albany by Senator Ford. The following is an extract from the memorandum of approval:

The privilege of using the streets of New York, above or below the surface, is of great value, and when such privilege is extended to persons or corporations the city's interest should be carefully guarded. There is no provision in the present bill for compensation to the city for the rights conveyed therein. I suggest, therefore, that a bill be passed requiring the company referred to in the bill to pay to the city of New York not less than 3% of its gross receipts for the first 20 years, and that each 20 years thereafter a readjustment of the amount to be paid should be made by the municipal authorities. While referring specifically to this bill, I desire to be understood as believing in the case of all corporations that are privileged to use the streets of New York proper compensation should be made to the city, and that the rights of the city should be as carefully guarded as any other of its property interests.